The phlebotomine sandflies (Diptera : Psychodidae) of the Oriental Region

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Synopsis

A key is given for the 122 species and two subspecies of Phlebotominae known from the Oriental Region, which are grouped in two genera. Taxonomic citations include all those necessary for reference to early works. Seventeen new species and one subspecies are described and named, and three species are described and given vernacular names. Many existing descriptions are amplified.

Detailed study showed the significance of some structures not normally used in taxonomy, including features of the stylets and sculpture of the pigment patch. Long-standing problems of *Phlebotomus argentipes*, the *Sergentomyia babu* complex, *S. malabarica* and *S. perturbans* were investigated. Variation in *P. argentipes* is associated with biological differences in host choice and disease transmission. Many new localities are recorded and the distribution of each species is mapped. Aspects of biology are reviewed with special reference to general distribution, biting habits and seasonal distribution. Medical importance is summarized.

Introduction

Only three species of Phlebotominae were known in the world in 1905 when impetus was given to their study by their suspected association with sandfly fever and leishmaniasis. By 1925 47 more species were known, 14 of them from the Orient, including nine from India and two from Sri Lanka. In 1926 Adler and Theodor discovered the taxonomic value of cibarial teeth and spermathecae, giving further impetus to sandfly taxonomy, and by 1970 649 taxonomic names had been proposed. Devastating epidemics of kala-azar, discussed in a later section, had led to intensive research during which J. A. Sinton published a long series of important taxonomic papers, mainly on India and Pakistan, from 1921 to 1933. Raynal and Gaschen investigated Indo-Chinese species, a few other workers studied some Oriental species, and Quate recently made important contributions from south-east Asia. Otherwise, interest waned because kala-azar came under control, and was not present in south-east Asia to stimulate research. Recently, however, several factors have rekindled interest in Oriental Phlebotominae and necessitated a taxonomic review. Reduction in anti-malarial house-spraying has led to some recrudescence of kala-azar. Several viruses have been found in sandflies, and the modern interest in zoonoses, animal reservoirs of leishmaniasis, and possible additional vectors has led to much collecting in outdoor habitats. Improved trapping methods have yielded large collections for study.

In the present work 17 species and one subspecies are described as new, some by D. J. L. & J. Jeffery and the others by D. J. L. Several existing descriptions are amplified and the males of some species are described for the first time. The 124 taxa now known from the Region comprise 122 species and two subspecies. More species may exist, for Quate & Fairchild (1961) expected more to be found in West (Peninsular) Malaysia and Borneo, and Quate (1965) trebled the number of known Philippine species, and estimated that a hundred might exist.

In the section on biology several aspects are summarized, including seasonal occurrence which is important for planning future surveys.

The data of specimens critically examined for the descriptions and measurements, including the type-specimens of new species and subspecies, are listed under 'Material examined'; all such specimens are in the BMNH unless otherwise stated. The data of type-specimens of previously described species are given in the synonymies and not repeated under 'Material examined'.

Under the heading 'Distribution' are listed data from several sources which can be distinguished by the form of annotation. Localities of specimens routinely identified for distribution records (but not used for the descriptions and measurements) are indicated by '(BMNH)' or by the collector's name in parentheses; in the latter case at least some of the specimens seen are also in the BMNH unless otherwise indicated. Published records are indicated by a reference to the published source. Records taken from the manuscript notes of J. A. Sinton are indicated by '(Sinton's notes)'. Localities of specimens already listed under 'Material examined' are marked '(as above)'. Dates of collection and other data are added only when thought to be of particular interest.

The length of the scale lines on the figures is given in millimetres.

Explanation of terms

Abbreviations and some terms are explained below

Antenna 3 etc.	Antennal segment 3 etc.
BMNH	British Museum (Natural History)
BPBM	Bernice P. Bishop Museum, Honolulu
Complex	A group of closely similar species or infraspecific forms
ICZN	International Code of Zoological Nomenclature
R_2 etc.	Wing veins: radius branch 2 etc.
Series	A group of species within a subgenus or species-group
Species-group	A group equivalent to a subgenus
TC	Theodor collection, Hadassah-Hebrew University Medical School, Jerusalem (location of types shown by personal communication, 1977)
ZMA	Zoological Museum, Amsterdam University

Methods

Many mounting media have been used for sandflies, and for the present work a variant of Berlese's medium (Lewis, 1973*b*) was employed which can be filtered through previously wetted filter paper during preparation. The medium is useful for rapid processing of large numbers of flies. To allow for shrinkage through evaporation, either specimens were left for some hours before addition of a cover glass, or mounts were topped up with mounting fluid after a few hours or a day. Slides were kept at about 37 °C, usually for about five weeks, till the peripheral mountant was brittle and no movement in thick mounts was noticed, but not long enough for cover glasses to become loose. Excess mountant was then removed with a needle, and cover glasses were ringed with Euparal which is more secure than the commonly used nail varnish.

Drying alters the refractive index and reduces the initial clarity of some ascoids and spermathecae, but this can be restored by re-wetting. If mounts are insufficiently dried Euparal may mix with the mountant, so that preparations become grey and specimens fragile. This process can take 20 years or more; it is a warning against adopting new methods without careful consideration.

Caustic potash (10 per cent) was not used for maceration, but the head of one old pinned fly was put in hot potash for one minute because dried tissues had distorted the cibarium.

It is often necessary to remount a sandfly, for reorientation, for examining spermathecae, or for studying such structures as the cibarial teeth of *S. cheongi* and the lower parameral lobes of *P. philippinensis*. For recovering a specimen from a sealed mount, a slide was briefly immersed in water, and Euparal was chipped away. A small square of cover glass above the specimen was isolated by thrusting a needle, plough-like, beneath the glass, and the water and debris were washed away and replaced by Berlese's medium. A fresh cover glass was added to keep the mount wet till it softened in a few hours or over-night. Water could be dropped on, or pipetted in, for rapid soaking, but might form an inconvenient precipitate or wash away small objects. Mounts, used thus for recovering specimens, serve as storage capsules which are better than vials of alcohol, for space-saving, upkeep, retrieval and inspection.

When sandflies in a collection are being mounted time can be saved if one or a group of species can be isolated provisionally from the others by means of external features. This can occasionally be done by observing size (large, medium or small), labrum length, dark or pale scutum or abdomen, and broad or narrow wings. Species provisionally separable in this way include *S. gombaki*, *S. iyengari* and *S. malayae*.

Identification of sandflies is often difficult for several reasons. For example, the appearance of internal taxonomic features may be affected by the condition of a fly, method of mounting, or degree of illumination. It is often difficult to associate the sexes, and the problem of finding larvae limits their use.

Measurements were made from Berlese mounts and did not alter appreciably with drying. Wing measurements could be slightly different if flies were examined in water.

If eyes were unusually large or small, their length, parallel to the head axis, was measured and divided by the head length measured from the clypeus tip to the level of the postero-lateral margins.

The cibarial teeth were counted in heads not subject to pressure. Compression may reveal a few more lateral teeth or spicules but spoils a specimen. Cibarial teeth numbering more than 60, often seen in subgenus *Parrotomyia*, are difficult to count unless they are magnified about 300 times and ticked on a camera lucida image. In some species with about 90 teeth the width of one was estimated by examining the median ones at about ×2000 and counting the number in a length of 0·008 mm.

If the inter-arcal area is dark or refractive it is occasionally necessary to separate the pigment patch from the ventral wall of the cibarium. This can be done by mounting the relevant part of the cibarium upside down in Berlese's medium and sliding the armature forward.

It is sometimes useful to examine a cibarium in longitudinal or transverse optical section. For this purpose a head, with antennae removed to facilitate orientation, may be left over-night in a drop of Berlese's medium, in which the soft parts become invisible but remain to preserve the shape. The drop is then wetted with fresh medium to prevent shearing, and the head cut in two with a razor blade. This, held with both hands, can be directed to within 0·02 mm or less of the objective. For lateral viewing the eyes are then removed for clarity and to facilitate orientation.

Preparation of the stylets of some species needs special care. For example, the maxillary lacinia of *S. iyengari* and the tip of a hypopharynx or a mandible are almost indistinguishable under a dissecting microscope, and are best mounted in situ on a slide after removal of other structures. Fortunately these time-consuming procedures are seldom necessary in routine work. Much detail of the fascicle can be seen if the labium is removed by drawing it sideways and backwards off the head.

Some antennal ascoids are very delicate, with their tips touching the antenna, and some distal ascoids can be small. In such cases the antennae are best mounted temporarily in water. The small ascoids of *S. malayae* are difficult to expose but can be seen well in occasional specimens. One ascoid was measured for each species, without the spur if present.

The presence or absence of a papilla on antenna 5 is of interest in some species. Its preparation and inspection sometimes take time if a fly is delicate or has been macerated in potash and mounted in balsam. In such a case papillae may be invisible, even under phase contrast, and must be remounted.

Palp segments are unsuitable for measuring if bent or shrunk. In this case a head may be temporarily mounted top-upward in dilute Berlese's medium so that the palps lie flat and expand.

If spermathecae are not visible in whole mounts the tip of the abdomen (sixth and succeeding segments) may be detached and slightly compressed from above (with a backward and forward movement) to release eggs or other loose objects and spread the segments. It is sometimes tempting to clear with potash but one should remember that the spermatheca used by the taxonomist is but a small and often delicate part of the whole spermathecal tissue (Theodor, 1965 : figs 3, 5E) and can easily be distorted by removal of soft parts. If ducts are delicate they can sometimes be exposed by removing virtually all external sclerites except the bifid sternum 8.

Complete descriptions of taxa would be too long. It is often necessary to omit mention of some group characters, absence of features which occur only in a few species, some features shown by figures, and some structures too small for regular inspection or only seen properly with the electron microscope. No description of a single species, therefore, can serve as a model, but the following list of structures includes most of those used in the present work.

♀. *Head*: labrum length and its relation to wing length, labral brush, labral apical, subapical, adoral and cibarial sensilla; cibarial shape and pigmentation, armature, pigment patch and arch, and relative width of the underlying salivary pump; pharyngeal shape and armature of the dorsal, and sometimes ventral, plates; hypopharyngeal teeth; antenna 3 (length and its relation to wing length, 4+5, and labrum; number of ascoids on 3–15, or 16, and shape and relative length of that on 4; presence or absence of papilla on 5); mandible (sharp or blunt tip, width and evenness of teeth); maxilla (shape, number of lateral and ventral teeth, and dental depth, in sample specimen; palpal segment ratio; distribution of Newstead's spatulate sensilla, i.e. in most Old World species scattered or bunched on segment 3). *Thorax*: scutal and pleural pigment; pleural hairs if present; inter-precoxal lobes (Sinton, 1928 : 745) if not narrow as normal; wing (length and relation to width, R_2/R_{2+3}, R_1 overlap/R_2); leg ratios, and femoral spines if present. *Abdomen*: erect-hair sockets if present on tergites 2–6, best seen from above; sperma-

theca (shape and markings, collar if distinct, knob and surrounding pit, ducts and common duct if present; furca and cercus if unusual).

♂. *Head*: labrum length and its relation to wing length; cibarial teeth and pigment patch; pharynx; antenna (as for ♀); palpal ratio. *Thorax*: wing (as for ♀); femoral spines if present. *Abdomen*: standard taxonomic features of aedeagus, filaments and pump, paramere, coxite and its brush, and style.

Features sometimes used. ♀: eye length, distance between eyes, interocular suture, arrangement of hair sockets on head, markings on pigment patch, shape of cornua, hair sockets on basal costal node of wing, nature of abdominal sternite 2. ♂: long antenna 1 and 2, large abdominal tergite 6, sternite 2, very long hairs on terminalia, shape of surstyle. Early stages: seldom found in nature; various features can be studied in eggs, larvae and pupae obtained by breeding. Patterns have sometimes been discernible on eggs in gravid females, like that of *S. jamesi*.

Taxonomic features

The anatomy of sandflies has been described wholly or partly by Forattini (1973), Lewis (1973*b*; 1975*a*), Perfil'ev (1968), Theodor (1958; 1965) and many others, and here it will suffice to mention particular features.

The length of the labrum is taken as the distance from the tip of the clypeus (omitting membranous connections) to the tip of the distal sensilla in the female, and to the tip of the inconspicuous small hood which covers them in the male. The labral sensilla of females are usually in four groups, namely apical, subapical, adoral (along the shaft) and cibarial (mainly proximal to the tip of the clypeus). Numerous variations include merging of adorals into subapicals or cibarials, and differentiation of adorals into a fore and a submedian hind pair of rows. The pattern of sensilla varies between many individuals and species but cannot practically be included in all descriptions. The labral sensilla appear more or less equivalent to those of mosquitoes (Lewis, 1975*a*), certain of which have some subgeneric significance.

The dorsal wall of the cibarium in the American *Brumptomyia* França & Parrot and *Lutzomyia* França has a hind bulge which, according to Theodor (1965 : 173, 174), is unknown in Old World species. Many of the latter, however, do have a bulge (Figs 117, 118, 181, 182, 186, 228–231, for example) which, in *S. knudseni* at least, is less pronounced than in *Lu. panamensis* (Shannon) (Fig. 232) and in the two species shown in sagittal section by Theodor.

The ventral wall of the cibarium between the chitinous arch and the arc of the hind teeth (here called the inter-arcal area) varies in shape and is sometimes pigmented. The terms concave and convex, applied to the cibarial and pharyngeal armatures, refer to their posterior borders.

The cibarium of most species of *Phlebotomus* either is unarmed, with merely scattered minute spicules, or has scattered large and small spicules. Large ones are occasionally bigger than the teeth of some *Sergentomyia*, which, however, are distinguishable by their linear arrangement. In a few species, such as *S. hassani* and *S. reidi*, some teeth extend onto the cibario-pharyngeal membrane.

The hind teeth in *Sergentomyia*, seen in ventral view, are often more or less foreshortened, and in *S. reidi*, and possibly some others with pear-shaped teeth, the appearance is completely altered by crushing.

In *S. perturbans*, *S. reidi* and some other species with a few strong teeth, the cibarial wall at their bases is thick and refractive and probably acts like the base of a harrow supporting a row of tines. The appearance is complicated in *S. reidi* by the presence of lines on the pigment patch which, in sandflies, is nearly in the same focal plane as the teeth (Theodor, 1965 : fig. 1, AB).

In some females of *S. barraudi* the hind margin of the ventral cibarial wall has a row of lumps which may be fore teeth displaced backwards.

The antennal ascoid formula is often used in males of *Phlebotomus* but varies in forms such as *P. longiductus*, and one ascoid of a pair may be vestigial. The length of an ascoid on antenna 4 is sometimes a useful specific character (Parrot, 1940; Lewis, 1975), but (Schmidt & Schmidt, 1962) *P. papatasi* and *P. argentipes* (discussed later) show great variation. Antenna 5 bears a papilla in most *Phlebotomus* but not in *P. betisi or P. argentipes*.

Occasionally hairs diverge widely from the shaft of the antenna (as in *S. musai*) or enwrap it closely and obscure the joints so that the antenna looks like a thread (as in *S. hamidi* and *S. traubi*).

The basal width of the main teeth of the mandibular armature (excluding extremities) may be measured by dividing a length of about 15 μm by the number of teeth in it. Teeth can be described as small (about 0·9 μm), normal (about 1·5 μm as in *S. antennata* (Newstead)), or large (about 2·5 μm as in *S. fallax* (Parrot)).

The base of the first maxillary palpal segment was taken as its junction with the blade. It and other segments are often rather soft, and their apparent lengths depend somewhat on mounting methods, but approximate measurements of some segments can be useful. Segments 2 and 3 have distal knobs.

Wing length is a useful indication of the size of a fly. The length in female sandflies ranges from 1·37 mm (a small *S. barraudi* from West Malaysia) to 3·8 mm (*P. gigas* Parrot & Schwetz), and species can be grouped around the figures 1·5 mm, small, 2·2 mm, medium size, 2·7 mm, large, and 3·6 mm, very large. The wings of males are shorter, and in one male of *S. tiberiadis* from Saudi Arabia are only 1·17 mm long.

Lengths of the femur, tibia and basitarsus of each leg can be useful (Quate, 1962*b* : 252; Quate & Fairchild, 1961 : 204; Quate & Rosario, 1962 : 788), and are here expressed as the length of the femur followed by a ratio.

The femoral spines present in a few species come off easily and may be difficult to detect or count in some specimens, because their sockets are rather like those of large hairs. If the legs become detached before spines are examined the legs can be recognized as first, second or third by the lengths of their tibiae.

The appearance of the spermatheca can vary according to the mounting medium used. The internal ridges in *S. dhandai* are conspicuous in water but soon disappear in Berlese's or probably any other medium. The spermatheca of *S. barraudi* looks different in Fig. 64 and in Quate's (1962*b*) fig. 4d, and that of *S. zeylanica* in Fig. 204 and in Theodor's (1938) fig. Vf and in Quate's (1962*c*) fig. 1f. In the latter instance a spermatheca of one type simulates another, and in the best conditions it is sometimes difficult to differentiate a swollen tube from a narrow capsule. The true shape may be obscured by disorientation, contraction or pressure from developing eggs, and in many mounts the spermatheca is invisible. The collar is often a useful feature but may be too indefinite. The spermatheca, an essential taxonomic character, must sometimes be carefully studied in several individuals, preferably parous flies with no fat-body or developing eggs, or gravid ones after detachment of terminal segments from the eggs.

The shape of the tip of the aedeagus is important but is sometimes intermediate between blunt and sharp.

Classification

Classification of the Phlebotominae began in 1911 and some aspects are still debatable. The system of Theodor (1948; 1958) is broadly followed here.

The difference between Old and New World sandflies is real but difficult to define precisely (Lewis, 1975*a*; Lewis & Lane, 1976). The significance of the dorsal wall of the cibarium, as shown above, seems to be less clear than was thought. A very general difference between Old and New World groups lies in the pattern of erect hairs on abdominal tergites 2–6. In the New World this varies greatly (Lewis, 1975*b* : 366) but in the Old World there appear to be only two main patterns.

Theodor's subgenera of *Sergentomyia* have not been universally adopted, and even he evidently regarded '*Rondanomyia*' (*Neophlebotomus*) as not very well defined (1958 : 48), treated it with some reservations, and included two exceptional species when dealing with the Palaearctic Region only. The subgenera are used here because they avoid an unduly large assemblage of ungrouped species, and facilitate faunal comparison with other regions. Some Oriental species of *Sergentomyia* are easily placed in the subgenera *Parrotomyia* and *Neophlebotomus*, and others less easily.

Many, however, outside the distinct *Sergentomyia*, *Grassomyia* and *Sintonius*, form a miscellaneous category of species, some of which may be loosely connected with subgenera. Subdivisions of three subgenera are discussed later.

Considerable infraspecific variation is seen in the ascoids of *P. argentipes*, the cibarium of *S. barraudi*, the maxilla of *S. indica* and various features of some other species. Divergent interpretations have led to the existence of many synonyms, and to complex taxonomic citations of species like *S. iyengari*. These become permanent features of catalogues, but may be reduced by the use of informal names for little known taxa.

Key to the species and subspecies of Oriental Phlebotominae

The following key, like all keys, is based on a few of the many characters of each species, therefore for many species it is intended as an aid, and not a means, for identification. For some sandflies, particularly some members of the subgenera *Parrotomyia* and *Neophlebotomus*, it is necessary to examine several females and a male; the females, which are of more biological interest, often have better characters, and a single one may have spermathecae shrunk or obscured by developing eggs. These subgenera are difficult to define, and it is advisable to follow each in the key in the case of problematical species.

The spermathecae provide important taxonomic features but those of genus *Sergentomyia* are little used in the key because they are often difficult to see.

The key will require modification when some of the species are better known.

The following forms are omitted from the key. The female is unknown in *P. nuri* and *newsteadi*, and *S.* A sp., B sp., Besout sp., *brevinervis*, *displicata*, *kachekensis*, *morini*, *pooi*, Rabok sp. and Sepilok sp. The male is unknown in *P. betisi*, *sejunctus*, *teshi* and *tubifer*, and *S. chakravarti*, *cheongi*, *dayapensis* (identity doubtful), *dentacea*, *exastis*, *hamidi*, *jamesi*, *kauli*, *lagunensis*, *mahadevani*, *modii*, *musai*, Okinawa sp., *pachystoma*, *spinifaucis*, *tonkinensis*, *tracheola* and *yoshimotoi*. Forms insufficiently described are *S. angustipennis* (♀ and ♂), *bigtii* (♂), *nankingensis* (♂), and *torrechantei* (♂). These lacunae should not affect identification unduly because some of the species are rare or local, and most gaps represent males of genus *Sergentomyia* in which most determinations are based on the female.

1 Cibarial teeth absent or, if present, usually in the form of spicules and not in a definite row (Fig. 27). Pigment patch nearly always absent. Hind ends of abdominal tergites 2–6 with many erect hairs (Fig. 1), sockets as large as on 1. Style of male with three to five spines (Figs 19, 25) and sometimes (some species of subgenus *Idiophlebotomus*) with two hairs as well (genus ***PHLEBOTOMUS***, p. 233) 2

– Cibarial teeth in a transverse row (Fig. 65), fore teeth sometimes present (Figs 136, 245) and usually pointing upward. Pigment patch (Figs 66, 136) usually present. Hind ends of abdominal tergites 2–6 usually with all or most hairs recumbent, most sockets much smaller than on 1 except in *S. musai*. Style of ♂ with four major spines and an accessory seta (Fig. 80) (genus ***SERGENTOMYIA***, p. 252) 43

2 Cibarium with teeth. Pharynx unarmed. Palp not extending further than antenna 3. Style of ♂ with three to five spines, and a pair of intra-abdominal rods (subgenus ***IDIOPHLEBOTOMUS***, p. 250) 3

– Cibarium with spicules or unarmed. Pharynx usually armed. Palp extending further than antenna 3 15

3 Female 4

– Male 11

4 Cibarial armature with median rod 5

– Cibarial armature without median rod 9

5 Cibarial median rod with large serrations . . . . . ***P. asperulus*** (p. 250)

– Cibarial median rod with minute serrations or none 6

6 Cibarium without teeth except a few granulose spicules . . . . . ***P. erebicolus*** (p. 251)

– Cibarium with teeth 7

7 Cibarial teeth all short . . . . . ***P. pholetor*** (p. 251)

– Some or all cibarial teeth long 8

8 Cibarial teeth in radiating lines . . . . . ***P. tubifer*** (p. 252)
– Cibarial teeth not in lines, very long, and parallel . . . . . ***P. frondifer*** (p. 251)
9 Cibarial teeth all small . . . . . ***P. stellae*** (p. 251)
– Cibarial teeth not all small 10
10 Median tooth the longest . . . . . ***P. teshi*** (p. 252)
– Anterior teeth the longest . . . . . ***P. sejunctus*** (p. 251)
11 Apical spine of style with marked basal expansion . . . . . ***P. asperulus*** (p. 250)
– Apical spine of style without marked basal expansion 12
12 Style with three spines . . . . . ***P. erebicolus*** (p. 251)
– Style with more than three spines 13
13 Style with four spines . . . . . ***P. frondifer*** (p. 251)
– Style with five spines 14
14 Aedeagus prominent and capitate; paramere slender and without dorsal appendage ***P. pholetor*** (p. 251)
– Aedeagus small and triangular; paramere with basal dorsal curved appendage ***P. stellae*** (p. 251)
15 Coxite of ♂ with sub-basal hairy process. Genital filaments 1·3–2·3 times as long as pump . 16
– Coxite of ♂ without such process. Genital filaments 3–11 times as long as pump . . . 24
16 Coxite 0·37–0·74 mm long, its process very small. Style long and cylindrical with three terminal spatulate spines and two other spines. Paramere with two dorsal processes. Surstyle with terminal spines. Pharyngeal armature comprising either a network of lines or scales. Spermatheca with nearly equal segments and a refractive membrane (Figs 2, 3) near bases of ductules (subgenus ***PHLEBOTOMUS***, p. 233) 17
– Coxite 0·20–0·33 mm long, its process usually large and having a brush of long hairs. Style not long, with four or five spines. Paramere simple, distal upper surface flat and elliptical with short hairs. Surstyle without terminal spines. Pharynx of ♀ with teeth or scales. Spermatheca sometimes with differentiated rounded end-segment 19
17 Female . . . . . ***P. papatasi*** (p. 233) or ***P. salehi*** (p. 235)
– Male 18
18 Upper parameral lobe much longer than paramere. Surstyle with two, or sometimes three, similar spines . . . . . ***P. papatasi*** (p. 233)
– Upper parameral lobe same length as paramere. Surstyle with seven spines, large to very small . . . . . ***P. salehi*** (p. 235)
19 Style with five long spines, two at the tip and two near the middle. Pharynx of ♀ with irregular scales or punctiform teeth (subgenus ***SYNPHLEBOTOMUS***, p. 236) ***P. eleanorae*** (p. 237)
– Style with four long spines, two near the tip and two near the base. Pharynx of ♀ with large backwardly directed teeth (subgenus ***PARAPHLEBOTOMUS***, p. 235) . . . 20
20 Female 21
– Male 22
21 Antenna 3 short (0·12–0·16 mm), 0·5–0·6 length of labrum . . . ***P. alexandri*** (p. 235)
– Antenna 3 long (0·23–0·33 mm), 0·7–1·0 length of labrum . . . ***P. sergenti*** (p. 236)
22 Basal process of coxite very large and thick with many hairs on its distal third ***P. nuri*** (p. 236)
– Basal process of coxite small and thin with hairs only at its end 23
23 Antenna 3 short (0·12–0·16 mm), 0·7–0·9 length of labrum. Genital pump short (0·12 mm) with small basal plate or funnel . . . . . ***P. alexandri*** (p. 235)
– Antenna 3 long (0·25–0·34 mm), 1·0–1·4 length of labrum. Genital pump long (0·17–0·2 mm) with broad basal plate . . . . . ***P. sergenti*** (p. 236)
24 Style with four long spines of which one is terminal, one subterminal, and two near the middle.

Paramere with two or three lobes, with or without accessory spine. Aedeagus short and conical. Pharynx with a small group of teeth in the middle and behind it some concentric lines. Spermatheca segmented, apical segment not enlarged (subgenus ***ANAPHLEBOTOMUS***, p. 247) 25
– Style with five long spines 30
25 Female 26
– Male 28
26 Spermatheca slightly carrot-shaped with small end-segment, individual duct about four (possibly more) times length of spermatheca.

Sternal tubercle broad . . . . . ***P. colabaensis*** (p. 247)

– Spermatheca spindle-shaped with very narrow cylindrical apical segment, duct short but common duct very long.
Ascoids long. Palpal segment 3 with peg sensilla grouped around middle . . . 27

27 Pharyngeal armature with antero-median numerous long pointed teeth which blend laterally with ridges. Individual ducts longer than spermathecae . . . . ***P. stantoni*** (p. 248)

– Pharyngeal armature with several antero-median rows of small short teeth, and antero-laterally a number of backward-pointing teeth. Individual ducts shorter than spermathecae . . . . . ***P. hoepplii*** (p. 247)

28 Paramere bilobed . . . . . ***P. colabaensis*** (p. 247)

– Paramere trilobed 29

29 Spine near aedeagus not longer than it. Pharynx with a series of oblique ridges radiating from mid-line and ending in loops laterally . . . . . ***P. stantoni*** (p. 248)

– Spine near aedeagus much longer than it. Pharynx with a series of posterior ridges and, antero-laterally, a number of teeth projecting medio-posteriorly . . ***P. hoepplii*** (p. 247)

30 Paramere with three lobes (two in an Iranian species). Pharynx of ♀ as in *Anaphlebotomus*
Spermatheca with differentiated end-segment (subgenus ***EUPHLEBOTOMUS***, p. 240) . 31

– Paramere without ventral process. Pharyngeal armature otherwise 38

31 Female 32

– Male 35

32 Spermatheca with faint transverse striations . . . . . ***P. kiangsuensis*** (p. 244)

– Spermatheca distinctly segmented 33

33 Spermathecal common duct with rather thin walls. Antenna 5 without papilla ***P. argentipes*** (p. 240)

– Spermathecal common duct with thick walls. Antenna 5 with papilla 34

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Interarcal area sclerotized and wrinkled. Antenna 3 about 1·3 length of labrum, ascoids with spur. Tergite 8 with patch of hairs on each side . . . . . ***S. pachystoma*** (p. 304)
183 Cibarium with nine teeth . . . . . ***S. kelantani*** (p. 300)
– Cibarium with 12–27 teeth 184
184 Cibarium with 12–15 teeth . . . . . ***S. hitchensi*** (p. 299)
– Cibarium with 24–27 teeth . . . . . ***S. knudseni*** (p. 300)

185 Cibarium with patch of teeth behind main teeth . . . . . ***S. reidi*** (p. 305)
– Cibarium without such patch 186
186 Style with two of spines subterminal and seta near base, and cibarial teeth small ***S. hitchensi*** (p. 299)
– Without this combination 187
187 Cibarium with faint median hind process and no definite teeth . . ***S. anodontis*** (p. 295)
– Cibarium otherwise 188
188 Palpal segment 4 nearly twice length of 3
Cibarium with 12 short linear teeth and ten fore teeth in two rows ***S. dapsilidentes*** (p. 296)
– Palpal segment 4 not so long 189
189 Cibarium with six to ten barb-like teeth, six fore teeth and a long antenna 3, 0·31 mm
S. delfinadoae (p. 296)
– Without this combination 190
190 Cibarium with many small triangular teeth of different sizes tending to form two rows in the centre . . . . . ***S. fanglianensis*** (p. 297)
– Cibarial teeth not like this 191
191 Cibarium with eight prominent diamond-shaped hind teeth and eight fore teeth in two rows. Inter-arcal area pigmented . . . . . ***S. heiseri*** (p. 299)
– Cibarium not like this 192
192 Cibarium with about eight sharp spike-like teeth, and 10–20 fore teeth, usually in one main row . . . . . ***S. imitor*** (p. 299)
– Cibarium otherwise 193
193 Cibarium with about eight distinct separated teeth on convex arc, a strong bulge, and pigment patch about two-thirds width of cibarium . . . . . ***S. knudseni*** (p. 300)
– Cibarium otherwise 194
194 Cibarium with seven to nine pear-shaped teeth, no fore teeth and pigmented inter-arcal area . . . . . ***S. losarcus*** (p. 301)
– Cibarium otherwise 195
195 Cibarium with 12–15 small teeth and eight fore teeth . . . . . ***S. maai*** (p. 301)
– Cibarium otherwise 196
196 Cibarium with about 18 teeth in one row, about three rows in front of them on each side, and a distinct pigment patch . . . . . ***S. montana*** (p. 303)
– Cibarium otherwise 197
197 Cibarium with six or seven groups of small fine teeth, and some fore teeth, and no pigment patch . . . . . ***S. morini*** (p. 303)
– Cibarium otherwise 198
198 Cibarium with six small but distinct teeth, five fore teeth in one row, and no pigment patch. Antenna 3 short, 0·11 mm, style with three apical and one subapical spines, and seta at 0·7
S. neras (p. 303)
– Without this combination 199
199 Cibarium with about six long teeth and about 18 irregular fore teeth . . ***S. pachystoma*** (p. 304)
– Cibarial hind teeth numbering 23–29; fore teeth numbering 10–15, those at centre less pointed than side ones . . . . . ***S. pooi*** (p. 305)

Taxonomy and distribution of species

Under each genus and subgenus references to descriptions are cited and brief notes are given on some characters and on distribution. Diagnostic summaries are included in the key.

The species in each genus are arranged in alphabetical order. The taxonomic citations include all references to Oriental species, except some out-of-date ones, and a few to species in other regions. Where holotypes were not studied, paratypes were often examined. Descriptions are given for new species and a number of others.

Specimens headed 'Material examined' were studied in detail. Many others were identified or checked, and some of them are indicated by italicized names of collectors in the distribution lists. Some localities are omitted, either because they cannot be traced, or because they are near other recorded localities, or because they were recorded before 1928 when few species of *Sergentomyia* were reliably identified. Table 2 gives the position of localities not shown on *The Times Atlas* of 1972. Map 1 shows the sources of all the material referred to in this study.

Genus *PHLEBOTOMUS* Rondani & Berté

Flebotomus Rondani & Berté *in* Rondani, 1840 : 12. Type-species: *Bibio papatasi* Scopoli, by monotypy.
Phlebotomus Rondani & Berté [emendation]; spelling fixed under suspension of rules by ICZN, 1954, Opinion 256 : 199; Theodor, 1948 : 96; 1958 : 16; 1965 : 179; Lewis, 1967 : 14.
Phlebotomus subgenus *Phlebotomus* Rondani & Berté; Quate, 1964 : 238.

Normally there is no row of cibarial teeth and no pigment patch. On the antenna there is a papilla on segment 5 and, in the male, two ascoids on segments 3–15. Erect hairs are present on abdominal tergites 2–6, and there are four or five spines on the style of the male. The genus is widespread in the Old World, and most species occur in the north.

Subgenus *PHLEBOTOMUS* Rondani & Berté

Phlebotomus subgenus *Phlebotomus* Rondani & Berté *in* Rondani, 1840 : 12; Theodor, 1948 : 96; 1958 : 16; Perfil'ev, 1968 : 227; Hennig, 1972 : 53.

The pharynx bears ridges or scales and the spermathecal segments are equal. The genital filaments are short, each paramere bears two processes, the long coxite carries a lobe and the style is long. The subgenus is represented in the west of the Region.

Phlebotomus (*Phlebotomus*) *papatasi* (Scopoli)

(Figs 1–5, Map 2)

Bibio papatasi Scopoli, 1786 : 55. No types mentioned: Italy.
Phlebotomus papatasii; Howlett, 1915 : 294 [misspelling]; Sinton, 1924*a* : 814; 1925*a* : 468 [surstyle variation etc.]; 1925*d* : 107; 1927*d* : 27; 1928*c* : 300 [synonymy]; 1932*a* : 59; 1933*d* : 418; Sinton & Barraud, 1928 : 329; Mukerji, 1931 : 442 [larva]; Mitra, 1952 : 550 [palp sensilla]; Mitra & Mitra, 1953*b* : 434.
Phlebotomus papatasi (Scopoli); Schmidt & Schmidt, 1962 : 723.
Phlebotomus (*Phlebotomus*) *papatasi* (Scopoli); Parrot, 1940 : 310; 1946 : 67; Theodor, 1948 : 106; 1958 : 17; Quate, 1964 : 240; Lewis, 1967 : 14; Perfil'ev, 1968 : 228; Abonnenc, 1972 : 99; Bhat & Modi, 1976 : 265, 266.

Recent full or partial descriptions were given by Abonnenc, Perfil'ev, Quate and Theodor.

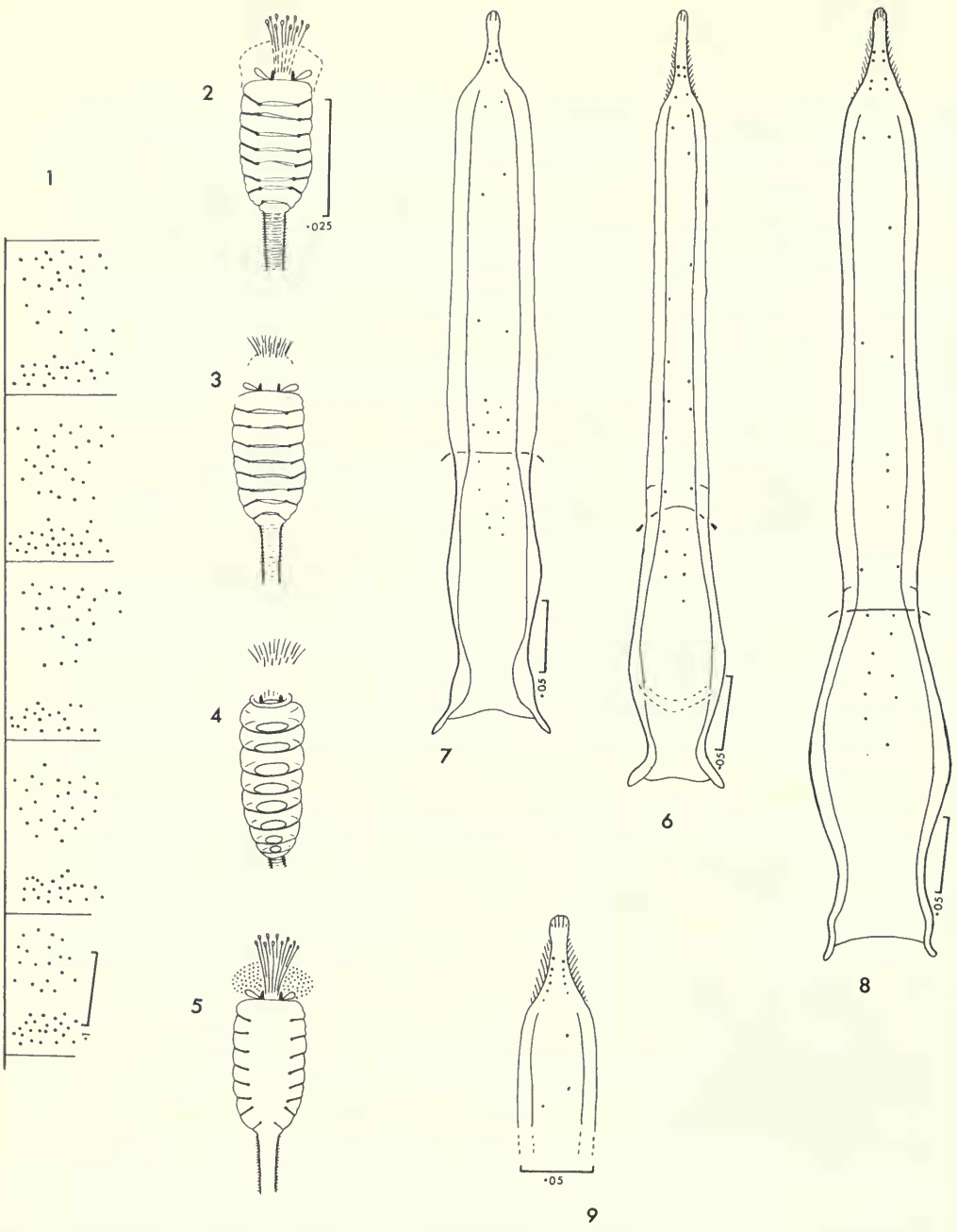
In the male there are two, and sometimes three, spines on the surstyle, the dorsal process of the paramere carries hairs only ventrally and is much longer than the rest of the paramere, and the first two spines of the style are close together. The pharyngeal teeth of the female form a wide-meshed network.

The proximal part of the spermatheca (near the ductules) has been variously described because its structure is difficult to see. Comparison of specimens in Berlese's medium and in water with Theodor's (1965 : 174) figure shows the following features. The chitinous capsule comprises about nine segments or hollow annuli, the most proximal of which is small and collar-like. The head has a thick lateral wall and is connected to the long ductules, the bases of which are obscured by a mushroom-like halo of refractive material which is part of the outer covering of the spermatheca.

♀ (*extra facts*). Labrum with upper brush-hairs blade-like, two median apical sensilla long and narrow and adorals small. Hypopharynx with about 16 teeth on each side. Maxilla with about six lateral and 17 ventral teeth, and a dental depth of 0·10 mm, clavate sensilla concentrated near middle of segment 3 of palp.

Material examined.
Pakistan: Taxla, 1 ♀.

Distribution. **Bangladesh:** Parbatipur, Rajbari (Sinton's notes). **India:** Pusa (Annandale, 1911*c* : 320; Barraud, 1926 : 214; Craighead & Das, 1928 : 862; Howlett, 1915 : 296); Howrah (*S. Das*); Osmanabad (*V. Dhanda*); Aurangabad, Jalna, Patan (Farooq & Qutubuddin, 1945 : 85); Baramula, Ramban, Riasi, Srinagar (Jacob & Kalra, 1951 : 325); Tibi (*N. L. Kalra*); Jalor (Kaul *et al.*, 1973 : 532); Jammu, Uri



Figs 1–9 *Phlebotomus* species. 1–5, *P. papatasi*, ♀: (1) abdominal tergites 2–6; (2) spermatheca in water; (3–5) same in Berlese's medium. 6, *P. betisi*, ♀, labrocibarium. 7, *P. kandelakii burneyi*, ♀, labrocibarium. 8, *P. keshishiani*, ♀, labrocibarium. 9, *P. major major*, ♀, tip of labrum.

(Mitra, 1953*a* : 324); Hoora (Mitra, 1953*b* : 158); Khandwa, Mahad, Mahableshwar, Mundwa, Panchgani, Poladpur, Wai etc. (Mitra, 1954*a* : 111; 1955 : 82); Nowshera in Kashmir (Mitra, 1959 : 59, 62); Hyderabad (commonest species, Qutubuddin, 1944 : 208); Kotelanka, Undi etc. (*R. Reuben*); Bikaner (Sharma *et al.*, 1973*c*); Kirki, Poona (Sinton, 1924f : 1042); Bombay, Maini Majera, Mandapam, Melur, Nagpur, Pamban Island, Roorkee, Saharanpur etc. (Sinton, 1927*b* : 942); Calcutta, Madras (Sinton, 1932*a* : 70); Sagar (Sinton, 1932*c* : 577); Agra, Ajmer, Anandpur area, Coimbatore area, Dehra Dun, Ferozepore, Lucknow, Madhopur, Mahendragarh, Mescara, Naini Tal area (Sinton's notes). **Pakistan:** Abbottabad, Bannu, Chaman, Chilas, Dera Ismail Khan, Digri, Gilgit, Hyderabad, Idak, Jamesabad, Jamrud, Jandola, Jhelum, Kandhkot, Karachi, Kashmore, Khairpur, Khirgi, Kohat, Lahore, Landi Kotal, Larkana, Miramshah, Mir Muhammad, Mirpur Kas, Nowshera, Pano Aqil, Peshawar, Quetta, Rawalpindi, Saidpur, Shikarpur, Tando Bago, Tank, Taxla (Lewis, 1967 : 14); Kotkai, Multan (Sinton's notes).

According to Sinton (1932*a* : 70) this species was scattered all over the plains of India, especially in hot dry areas, and was found as far east as Calcutta and as far south as Madras, but was commonest in the north-west. He (1925*b* : 703) did not find it above 610 m in eastern India, probably because the monsoon makes the hills too wet.

Phlebotomus (*Phlebotomus*) *salehi* Mesghali

(Map 2)

Phlebotomus (*Phlebotomus*) *salehi* Mesghali, 1965 : 264; Mesghali & Rashti, 1968 : 770 [♀]; Kalra & Lewis, 1976 : 522. Holotype ♂, IRAN (depository not stated) [not examined].

In the male the dorsal process of the paramere is shorter than in *P. papatasi*, and the surstyle bears seven spines ranging from large to very small.

♀ (*extra facts*). Labrum and maxillary sensilla as in *P. papatasi*. Hypopharynx with 17 teeth on each side. Maxilla with six lateral and 17 ventral teeth and a dental depth of 0·08 mm.

MATERIAL EXAMINED.
India: Tibi area, 1 ♀.

DISTRIBUTION. **India** (Rajasthan): Bikaner and Tibi areas (Sharma *et al.*, 1973*a*; 1973*b*; Kalra & Lewis, 1976).

Subgenus *PARAPHLEBOTOMUS* Theodor

Phlebotomus subgenus *Paraphlebotomus* Theodor, 1948 : 97; 1958 : 19; Perfil'ev, 1968 : 232. Type-species: *Phlebotomus sergenti* Parrot, 1917, by original designation.

The sub-basal process of the coxite is medium-sized to large and bears long hairs, and the style has four spines. This subgenus occurs mainly in the Palaearctic Region where it includes some closely related species. It is represented in the west of the Orient.

Phlebotomus (*Paraphlebotomus*) *alexandri* Sinton

(Map 3)

Phlebotomus sergenti var. *alexandri* Sinton, 1928*c* : 308. Type not indicated, PAKISTAN (depository unknown) [not examined].
Phlebotomus alexandri Sinton; Sinton, 1932*a* : 58; 1933*e* : 418.
Phlebotomus (*Phlebotomus*) *alexandri* Sinton; Parrot, 1940 : 310; 1946 : 67.
Phlebotomus (*Paraphlebotomus*) *alexandri* Sinton; Theodor, 1958 : 19; Theodor & Mesghali, 1964 : 290; Lewis, 1967 : 15; Perfil'ev, 1968 : 241 [variation].

The authorship and date of *P. alexandri* are Sinton, 1932 : 58 (ICZN, 1964 : Article 10(b)). Perfil'ev and Theodor have given recent descriptions.

In the male the basal lobe of the coxite is thickened at the end and antenna 3 is short. The pharynx of the female is conical. This small sandfly with rather narrow wings looks rather like a species of *Sergentomyia*.

♀ (*extra facts*). Labrum and palp sensilla as in *P. papatasi*. Hypopharynx with about 16 teeth on each side. Maxilla with four lateral and nine ventral teeth, and dental depth of 0·06 mm.

MATERIAL EXAMINED.
Pakistan: Qambar.

DISTRIBUTION. **Pakistan:** Dehra Ismail Khan, Hyderabad, Kandhkot, Larkana, Parkuta, Qambar, Shikarpur, Tank (Lewis, 1967 : 15).

Phlebotomus (*Paraphlebotomus*) *nuri* Lewis

(Map 3)

Phlebotomus (*Paraphlebotomus*) *nuri* Lewis, 1967 : 15; Artemiev, 1974*a* : 160, 161. Holotype ♂, PAKISTAN (BMNH) [examined].

P. nuri is the only Oriental species with a large lobe on the coxite.

DISTRIBUTION. **Pakistan:** Rawalpindi, Said Pur (Lewis, 1967).

Phlebotomus (*Paraphlebotomus*) *sergenti* Parrot

(Map 3)

Phlebotomus sergenti Parrot, 1917 : 564; Sinton, 1924*a* : 814; 1928*c* : 307 [synonymy]; 1932*a* : 58; 1933*e* : 418; Sinton & Barraud, 1928 : 329. Syntypes ♂, ALGERIA (depository unknown) [not examined].
Phlebotomus (*Phlebotomus*) *sergenti* Parrot; Parrot, 1940 : 310.
Phlebotomus (*Paraphlebotomus*) *sergenti* Parrot; Theodor, 1948 : 97; 1958 : 21; Lewis, 1967 : 17; Perfil'ev, 1968 : 236; Artemiev, 1974*a* : 159, 160.

Perfil'ev and Theodor have given recent descriptions. The male has a slender basal lobe on the coxite and four spines on a short style. The female has strong pharyngeal teeth and four or five segments in the spermatheca.

♀ (*extra facts*). Labrum and palpal sensilla as in *P. papatasi*. Hypopharynx with 16 teeth on each side. Maxilla with seven lateral and 15 ventral teeth and a dental depth of 0·09 mm.

MATERIAL EXAMINED.
Pakistan: Ahmed Khel, 1 ♀.

DISTRIBUTION. **India:** Delhi, Karnal, Patiala (BMNH); Aurangabad (rare, Farooq & Qutubuddin, 1945 : 85); Banihal, Islamabad area, Srinagar (Jacob & Kalra, 1951 : 324); Abu Mount, Sambhar (Jaswant Singh, 1933); Jaipur (Kaul *et al.*, 1973 : 532); Mandi, Mendhar, Nowshera, Punch, Rajouri, Riasi (Mitra, 1959 : 62); Maini Majera (Sinton, 1927*b* : 942); Agra, Aligarh (Uttar Pradesh), Ferozepore, Karnal, Mohindergarh (Hariana), Narnaul, Rajkot, Roorkee (Sinton's notes). **Pakistan:** Cherat, Chilas, Dehra Ismail Khan, Gilgit, Gol, Gwadi, Jhelum, Keris, Lahore, Landi Kotal, Mir Muhammad, Parkuta, Peshawar, Quetta, Rawalpindi, Said Pur, Shikarpur, Sukkur, Tank, Taxla (Lewis, 1967 : 17).

P. sergenti in Indo-Pakistan seemed to be confined to the plains north and west of the Bombay–Simla line (Sinton, 1932*a*), but extends a little beyond this area.

Subgenus *SYNPHLEBOTOMUS* Theodor

Phlebotomus subgenus *Synphlebotomus* Theodor, 1948 : 97; 1958 : 22; Lewis & Ledger, 1976 : 406. Type-species: *Phlebotomus martini* Parrot, 1936, by original designation.

The hairy lobe of the coxite is medium-sized to large and the style has five spines. All but one species of this small subgenus occur in tropical Africa.

Phlebotomus (*Synphlebotomus*) *eleanorae* Sinton

(Map 3)

Phlebotomus eleanorae Sinton, 1931*a* : 817; 1933*e* : 418. Holotype ♂, INDIA (BMNH) [examined].
Phlebotomus (*Phlebotomus*) *eleanorae* Sinton; Parrot, 1940 : 310; 1946 : 67.
Phlebotomus (*Synphlebotomus*) *eleanorae* Sinton; Mesghali, 1965 : 267 [♀]; Lewis & Ledger, 1976 : 406.

This is the only Oriental species in which the coxite is not very long and bears a distinctly visible lobe, and the style is not very long and has five spines. The pharynx of the female has median coarse teeth and the spermatheca 11–12 segments.

♀ (*extra facts*). Labrum 0·25 mm long, 0·13 length of wing (1·94 mm), with wide upper brush-hairs in short row. Hypopharynx with 16 teeth on each side. Antenna 3 = 0·19 mm long, 0·10 length of wing, 1·00 length of 4+5, 0·78 length of labrum.

MATERIAL EXAMINED.
Iran (Minab area): Chelo, 3.x.1964 (*A. Mesghali*), 1 ♀.

DISTRIBUTION. **India:** Karnal (Sinton, 1931*a* : 817).

Subgenus *LARROUSSIUS* Nitzulescu

Phlebotomus subgenus *Larroussius* Nitzulescu, 1931 : 274; Theodor, 1948 : 97; 1958 : 22; Perfil'ev, 1968 : 250. Type-species: *Phlebotomus major* Annandale, 1910*b*, by original designation.

The coxite has no lobe, the style bears five spines, the paramere is not truncated and bears no ventral process, and the spermatheca has an end-process. Two of the three Oriental species occur in the west.

Study of the fascicle has shown that some species have more than four labral adoral sensilla, and some have few maxillary lateral teeth.

Phlebotomus (*Larroussius*) *betisi* Lewis & Wharton

(Fig. 6, Map 3)

Phlebotomus (*Larroussius*) *betisi* Lewis & Wharton, 1963 : 117. Holotype ♀, WEST MALAYSIA (BMNH) [examined].

The pharyngeal spicules are almost invisible, and the spermatheca has about 22 long bead-like segments.

♀ (*extra facts*). Labrum 0·35 mm long, 0·15 length of wing, with four adoral sensilla near the subapicals. Pharynx with ridges and minute, almost invisible, spicules. Hypopharynx with 17 teeth on each side. Antenna 3 = 3 mm long, 0·16 length of wing, 1·32 length of 4+5, 1·01 length of labrum, segment 5 without papilla. Maxilla with seven lateral and 21 ventral teeth and a dental depth of 0·11 mm; palpal segment 3 with most sensilla near middle. Wing (2·23 mm) 3·2 times width, R_2/R_2+_3 3·60, R_1 overlap/R_2 0·18.

MATERIAL EXAMINED.
West Malaysia: Betis, 1 ♀.

DISTRIBUTION. **West Malaysia:** Betis, Kuala Trengan area (Lewis & Wharton, 1963).

Phlebotomus (*Larroussius*) *kandelakii* Shchurenkova

Phlebotomus kandelakii Shchurenkova, 1929 : 693. Syntypes ♀ ♂, U.S.S.R. (found in Tbilsi Tropical Institute) [not examined].
Phlebotomus (*Larroussius*) *kandelakii* Shchurenkova; Theodor, 1958 : 23; Perfil'ev, 1968 : 261.

The pointed aedeagus has ventral teeth and the spermatheca is very long with 30–35 segments.

Phlebotomus (*Larroussius*) *kandelakii burneyi* Lewis

(Fig. 7, Map 3)

Phlebotomus (*Larroussius*) *kandelakii burneyi* Lewis, 1967 : 17; Artemiev, 1974*a* : 160. Holotype ♂, Pakistan (BMNH) [examined].

P. k. burneyi differs from the nominate form in having two ascoids on antenna 3–7 in the male, and other features.

♀ (*extra facts*). Hypopharynx with 17 teeth on each side. Maxilla with four lateral and 17 ventral teeth and a dental depth of 0·08 mm.

Material examined.
Pakistan: Gwadi, 1 ♀.

Distribution. **Pakistan:** Gwadi, Kalam, Keris (Lewis, 1967).

Phlebotomus (*Larroussius*) *keshishiani* Shchurenkova

(Fig. 8, Map 4)

Phlebotomus keshishiani Shchurenkova, 1936 : 892. Syntypes ♀ ♂, U.S.S.R. (found in Tropical Institute of Tadzhikistan (SSR), Dushanbe (= Stalingrad)) [not examined].
Phlebotomus (*Larroussius*) *keshishiani* Shchurenkova; Lewis, 1967 : 19; Perfil'ev, 1968 : 274.

P. keshishiani differs from *P. major* in having much longer genital filaments, the aedeagus very narrow distally, and more spermathecal segments.

Material examined.
Pakistan: Parkuta, 1 ♀.

Distribution. **Pakistan:** Gilgit, Parkuta, Rawalpindi, Said Pur (Lewis, 1967).

Phlebotomus (*Larroussius*) *major* Annandale

Phlebotomus major Annandale, 1910*b* : 46.

The aedeagus is long and narrow with nearly parallel sides, about as long as the paramere. The species extends from the Mediterranean to Central Asia and northern India.

Phlebotomus (*Larroussius*) *major major* Annandale

(Fig. 9, Map 4)

Phlebotomus major Annandale, 1910*b* : 46; 1911*c* : 320; Newstead & Sinton, 1921 : 105; Sinton 1924*a* : 814; 1925*d* : 107; 1927*c* : 948 [variation]; 1927*d* : 27; 1928*c* : 303 [synonymy]; 1932*a* : 59; 1933*e* : 418; Sinton & Barraud, 1928 : 329. Lectotype ♂, India (Zoological Survey of India), designated by Quate, 1962*c* : 157 [not examined].
Phlebotomus major var. *grisea* Annandale, 1911*c* : 320. Syntypes, sex not stated, India (depository unknown) [not examined]. [Synonymized by Quate, 1962*c* : 157.]
Phlebotomus major var. *griseus* Annandale; Sinton, 1932*a* : 59 [name emended; dark variant].
Phlebotomus (*Phlebotomus*) *major* Annandale; Parrot, 1940 : 310; Quate, 1962*c* : 157.
Phlebotomus (*Larroussius*) *major* Annandale; Theodor, 1958 : 250; Theodor & Mesghali, 1964 : 281; Lewis, 1967 : 21; Perfil'ev, 1968 : 253.

The male of the nominate subspecies has a palpal formula of 1, 4, (2, 3), 5, and differs in a few other respects from two Palaearctic subspecies in which the formula is 1, 4, 2, 3, 5. *P. major major* was described in recent years by Perfil'ev and Theodor. It occurs in Pakistan and northern India.

In a male from Kasauli with an abnormal style one of the middle spines is replaced by two narrow ones, and in a male from Sabadu one style has only one terminal spine.

♀ (*extra facts*). Hypopharynx with 21 teeth on each side. Maxilla with four lateral and 26 ventral teeth, dental depth 0·12 mm.

MATERIAL EXAMINED.
India: Dalhousie, 1 ♀.

DISTRIBUTION. **India:** Paresnath Hill (Annandale, 1912 : 41); Bhowali, Dalhousie, vii.1906, Kasauli, 25.vi.1905, Simla (BMNH); Chamoli area (*V. Dhanda*); Banihal, Baramula, Islamabad, Jammu, Ramban (Jacob & Kalra, 1951 : 324, 325); Mandi, Mendhar, Punch, Rajouri, Riasi (Mitra, 1959 : 59, 62); Kurseong, Naini Tal (Quate, 1962*c* : 157); Chamba, Dehra Dun, Mukteswar (U.P.), Ranikhet, Sabathu (Punjab) (Sinton's notes). **Nepal:** Syabrudens (*L. W. Quate*, 28.x, 2.xi.1965, light trap). **Pakistan:** Abbottabad, Rawalpindi, Said Pur (Lewis, 1967 : 21).

Early records have been checked because some (Sinton, 1927*b*) could have referred to *P. longiductus* (='*P. chinensis*') which was often found in the same sites (Sinton, 1928*c* : 306). *P. m. major* seemed to occur all along the Himalayan foothills between 1555 and 2135 m, being, in India, essentially a species of hills with marked summer rains (Sinton, 1932*a*).

Subgenus ***ADLERIUS*** Nitzulescu

Phlebotomus subgenus *Adlerius* Nitzulescu, 1931 : 275; Theodor, 1948 : 98; 1958 : 27; Perfil'ev, 1968 : 280.
Type-species: *Phlebotomus chinensis* Newstead, 1916, by original designation.

The coxite has no lobe, the style bears five spines, and the paramere is not truncated and carries no ventral process. The spermatheca is incompletely segmented. In the male of most forms the aedeagus has a subterminal minute fin-like barb. The subgenus is closely related to *Larroussius*, and Parrot (1940) suggested possibly uniting them in view of their antennal formulae. The species occur in temperate or in arid parts of the Old World, and two exist in the north of the Orient. M. M. Artemiev (1977, in letter) is revising the *Adlerius* of Afghanistan.

Phlebotomus* (*Adlerius*) *chinensis Newstead

Phlebotomus major var. *chinensis* Newstead, 1916 : 191.

The barb on the aedeagus is 10–35 μm from the tip. The species was divided into several subspecies but is here provisionally treated as comprising only *chinensis*, *arabicus* Theodor and *balcanicus* Theodor, according to Artemiev's tentative suggestions (see under *P. longiductus*). Perfil'ev and Theodor gave recent descriptions. The species is almost entirely Palaearctic.

Phlebotomus* (*Adlerius*) *chinensis chinensis Newstead

(Map 4)

Phlebotomus major var. *chinensis* Newstead, 1916 : 191. LECTOTYPE ♂, CHINA: 'Wo Fu Hsu Temple, 1–6.vii.1914, co-type' (BMNH), here designated [examined].
Phlebotomus chinensis Newstead; Sinton, 1928*c* : 306 [in part, synonymy]; 1932*a* : 59; 1933*d* : 418; Yao & Wu, 1941*b* : 78.
Phlebotomus (*Adlerius*) *chinensis* Newstead; Theodor, 1958 : 28; Perfil'ev, 1968 : 280.

In the nominate form the barb of the aedeagus is 30–35 μm from the tip (not more than 20 in other forms) and the coxite brush has about 20 not very thick-standing hairs. *P. c. chinensis* is one of the three Palaearctic taxa. Perfil'ev and Theodor gave recent descriptions.

♀ (*extra facts*). Hypopharynx with 19 teeth on each side. Maxilla with four lateral and 19 ventral teeth and a dental depth of 0·11 mm.

MATERIAL EXAMINED.
China: 2 ♀, 3 ♂ paralectotypes (BMNH), one labelled as type; same data as lectotype.

DISTRIBUTION. **China:** Hainan (subsp.?, Leng, 1964 : 127); Kumming (subsp.?, Yao & Wu, 1941*b* : 79).

Phlebotomus (*Adlerius*) *longiductus* Parrot

(Map 4)

[*Phlebotomus chinensis*; Sinton, 1928*c* : 306 [in part].]
Phlebotomus chinensis var. *longiductus* Parrot, 1928 : 29; 1940 : 310 [♂ ascoid formula variable]; 1946 : 68. Syntypes 2 ♂, U.S.S.R. (depository unknown) [not examined].
Phlebotomus (*Adlerius*) *chinensis hindustanicus* Theodor, 1958 : 29, 30. Syntypes ♂, North-west of Indian Subcontinent (TC) [not examined]. [Synonymized by Lewis, 1967 : 21.]
Phlebotomus (*Adlerius*) *chinensis longiductus* Parrot; Theodor, 1958 : 29; Theodor & Mesghali, 1964 : 193 [?]; Lewis, 1967 : 21 [♂ ascoid formula variable]; Perfil'ev, 1968 : 285.
Phlebotomus (*Adlerius*) *longiductus* Parrot; Artemiev, 1974*a* : 163.

In the male the barb of the aedeagus is shallow and about 12–14 μm from the tip, and the coxite brush has 50–60 hairs.

Artemiev treated this form as a species in view of differences from Chinese *P. chinensis* in the number of hairs on the coxite and the shape and position of the aedeagus barb, sympatric relation to form *halepensis* Theodor and *P. simici* Nitzulescu, and sharp differences from the allopatric 'subspecies' of *P. chinensis* except *arabicus* Theodor, *balcanicus* Theodor and *tauriae* Perfil'ev, 1966 : 312, which could be subspecies of *P. longiductus*. He pointed out that *P. longiductus* occurs in southern U.S.S.R., Iran, Afghanistan and northern Pakistan, and that in Afghanistan it is a mountain cold-resistant species occurring from 1000 to 2800 m.

Recent descriptions have been given by Artemiev, Lewis, Perfil'ev and Theodor. In an occasional male from India one of the ascoids on antenna 8 is vestigial.

♀ (*extra facts*). Labrum 0·40 mm long, 0·14 length of wing (2·76 mm). Hypopharynx with 21 teeth on each side. Maxilla with three lateral and 23 ventral teeth and a dental depth of 0·12 mm.

Material examined.
Pakistan: Gwadi and Keris, 2 ♀.

Distribution. **India:** Bhowali, Kasauli, Simla (BMNH); Banihal (Jacob & Kalra, 1951 : 325); Punch (Lewis, 1967 : 23); Mandi, Mendhar (Mitra, 1959 : 62); Kurseong, Ranikhet (Sinton's notes). **Nepal:** Chobhar (*Jane Wilson*, 1976, in cave); Syabrudens (*L. W. Quate* via BPBM, 1965). **Pakistan:** Gilgit, Gol, Gwadi, Keris, Parkuta, Said Pur (Lewis, 1967 : 23).

In India *P. longiductus* was not usually found below 1555 m and occurred in the same area as *P. major*, according to Sinton (1928*c*; 1932*a*).

Subgenus ***EUPHLEBOTOMUS*** Theodor

Phlebotomus subgenus *Euphlebotomus* Theodor, 1948 : 98; 1958 : 32; Hennig, 1972 : 53 [related to *Phlebotomus* and *Anaphlebotomus*]. Type-species: *Phlebotomus argentipes* Annandale & Brunetti, 1908, by original designation.

The coxite has no lobe, the style bears five spines, and the paramere has three processes. Hennig's (1972) study of the paramere of a fossil species suggests that this is an ancient subgenus. There are five species in the Old World.

Phlebotomus (*Euphlebotomus*) *argentipes* Annandale & Brunetti

(Figs 10–16, Map 4)

Phlebotomus argentipes Annandale & Brunetti *in* Annandale, 1908 : 101 [authorship according to ICZN Article 51(c)]; Annandale, 1910*b* : 42; 1911*a* : 159; 1911*c* : 309; Howlett, 1915 : 294; França, 1922 : 14; Sinton, 1924*a* : 814; 1925*c* : 789 [colour variation]; 1925*d* : 107; 1927*d* : 27; 1928*c* : 301 [synonymy]; 1932*a* : 59; 1933*d* : 227; 1933*e* : 418; Christophers & Barraud, 1926 : 853 [?]; Christophers, Shortt & Barraud, 1926 : 177; Shortt, Barraud & Craighead, 1926 : 330; Sinton & Barraud, 1928 : 329; Mukerji, 1931 : 441 [larva]; Raynal, 1935*b* : 245; Raynal & Gaschen, 1935*g* : 737 [figs in 1935*h*]; Keilin & Tate, 1937 : 254; Mitra, 1952 : 550 [palp sensilla]; 1956 : 229; Mitra, 1953*b* : 434; Mitra & Roy, 1953*b* : 369

[variation]. Lectotype ♂, INDIA (Zoological Survey of India), designated by Quate, 1962*c* : 157 [not examined].

[*Phlebotomus zeylanicus* Annandale; Annandale, 1910*a* : 61. Misidentification according to Sinton, 1924*a* : 813; 1928*c* : 301.]

Phlebotomus marginatus Annandale, 1910*a* : 62; Sinton, 1932*a* : 59 [colour form]. Holotype ♀, SRI LANKA (depository unknown) [not examined]. [Synonymized by Theodor, 1948 : 108.]

Phlebotomus argentipes var. *marginatus* Annandale; Annandale, 1911*b* : 203; 1911*c* : 319.

Phlebotomus annandalei Sinton, 1923*a* : 744; 1924*a* : 815. Holotype ♂ (ICZN Article 73(a)), INDIA (depository unknown) [not examined]. [Synonymized by Sinton, 1925*c* : 789.]

Phlebotomus (*Phlebotomus*) *argentipes* Annandale & Brunetti; Parrot, 1937 : 116; 1940 : 310; 1946 : 68; 1953 : 114; Lewis, 1957 : 165; Quate & Fairchild, 1961 : 211; Quate, 1962*b* : 254; 1962*c* : 157 [synonymy].

Phlebotomus (*Euphlebotomus*) *argentipes* Annandale & Brunetti; Theodor, 1948 : 99; Lewis, 1967 : 23; 1973*a* : 246; 1973*c* : 147; Lewis & Killick-Kendrick, 1973 : 4.

Phlebotomus argentipes var. *glaucus* Mitra & Roy, 1953 : 372. 10 ♀ syntypes, INDIA (Museum of the Armed Forces Medical College, Poona) [not examined]. [Synonymized by Lewis, 1967 : 24.]

In the female the pharynx has a group of spines, and the spermatheca a large apical segment, and in the male a pair of spines lies parallel to the aedeagus, the paramere has three lobes and the style five spines.

Descriptions include those of Quate & Fairchild, Raynal (1935*b*) and Sinton (1925*c*).

The form *glaucus* is here treated as a synonym in the light of present knowledge of variation.

♀ (East India, Calcutta, Howrah). Eye 0·56 length of head. Labrum 0·25 (0·23–0·27) mm long, 0·12 (0·12–0·13) length of wing, shoulders angular, most sensilla small, the two mid-apical ones prominent. Cibarium with distinct spicules. Pharyngeal armature with median anterior teeth and lateral and posterior spiculate ridges. Hypopharynx with about 16 long teeth on each side. Antenna 3 = 0·22 (0·20–0·23) mm long, 0·11 (0·10–0·11) length of wing, 1·25 (1·25–1·34) length of 4+5, 0·87 (0·80–0·92) length of labrum, no papilla on 5, two ascoids on segments 3–15, that on 4 being 0·41 (0·30–0·53) length of segment. Mandible with very fine teeth about 1·2 μm wide. Maxilla with 8·8 (7–11) lateral teeth, 14·9 (13–17) ventrals, and a dental depth of 0·08 mm; palpal ratio 10 : 22 : 31 : 16 : 34, clavate sensilla close together around middle of segment 3. Scutum dark brown, pleuron pale, inter-precoxal lobes normal, mesanepisternum with about five to eight lower hairs. Wing length 2·06 (1·92–2·22) mm, 3·2 times width, R_2/R_{2+3} 1·91 (1·59–2·06), R_1 overlap/R_2 0·14 (0·09–0·20). Tarsi appearing silvery in some lights. Spermatheca carrot-shaped with about 15 segments, the end one large, outer wall of common duct diverging distally.

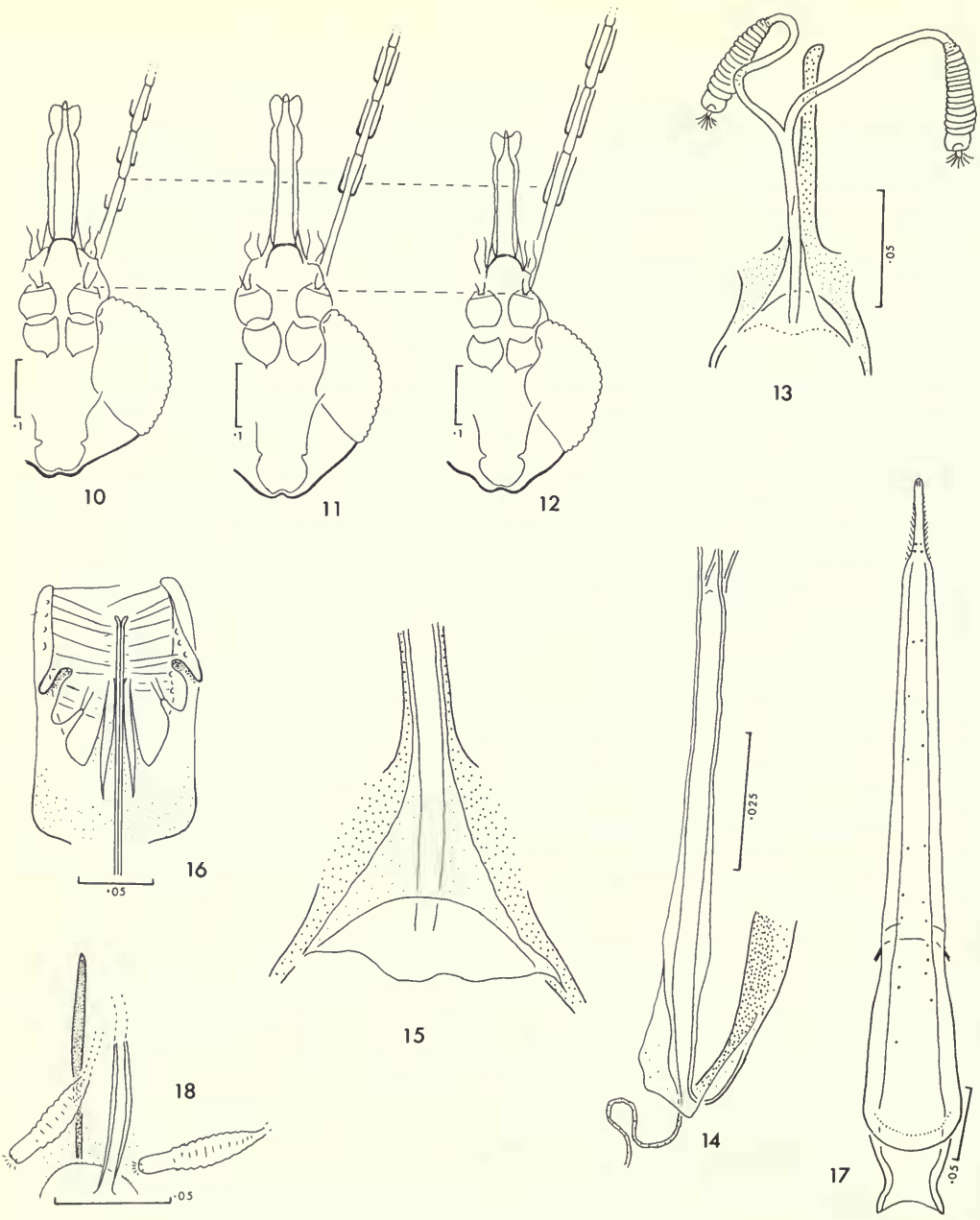
♂ (Calcutta area, *extra facts*). Eye 0·56 length of head. Style 0·62 length of coxite, 5·8 times as long as thickness (basad of middle spines).

VARIATION. This species was known to show some geographical variation (Lewis, 1957), and further observations were made on the limited material available owing to the importance of the species and its biological variation. In parts of India it bites man readily, is peridomestic, and is an important vector of kala-azar, whereas in south-east Asia it seldom if ever attacks man, and in Sri Lanka may be strongly zoophilic (Lewis & Killick-Kendrick, 1973). It has even been suggested, by R. S. Bray in 1974, that *P. argentipes* may be a species complex including a zoophilic and an anthropophilic species in one area.

Available specimens were limited, but those from several areas were examined for comparison with *P. argentipes* from the area around the type-locality of Calcutta, with the following results. In a few flies from some areas one maxillary lateral tooth is vestigial and makes counting difficult.

South India in general. Labrum 0·24 (0·22–0·27) mm long, 0·12 (0·12–0·13) length of wing. Antenna 3 0·22 (0·19–0·23) mm long, 0·11 (0·10–0·12) length of wing, 1·21 (1·18–1·25) length of 4+5, 0·88 (0·84–0·93) length of labrum. Ascoid on 4 = 0·49 (0·39–0·60) length of segment. Maxilla with 7·0 (6–11) lateral and 13·3 (14–19) ventral teeth. Wing length 2·03 (1·82–2·22) mm, R_2/R_{2+3} 1·74 (1·42–1·95), R_1 overlap/R_2 0·15 (0·09–0·21).

North India in general. Labrum 0·25 (0·24–0·27) mm long, 0·12 (0·11–0·12) length of wing. Antenna 3 = 0·22 (0·20–0·26) mm long, 0·10 (0·10–0·12) length of wing, 1·21 (1·14–1·33) length of 4+5, 0·88 (0·80–0·94) length of labrum. Ascoid on antenna 4 = 0·52 (0·33–0·74) length of segment (the highest value is in one of two flies from Bombay, with an antenna 3/labrum value of 0·83; otherwise the mean is



Figs 10–18 *Phlebotomus* species. 10–16, *P. argentipes*: (10–12) ♀, heads from India (Howrah), Sri Lanka (Pannipitiya) and West Malaysia (Lamir) (scales adjusted for wing length); (13) ♀, spermatheca (Venkatapuram); (14, 15) base of its duct (Venkatapuram and Lamir); 16, ♂, aedeagus and parameres (Lamir). 17, *P. kiangsuensis*, ♀, labrocibarium. 18, *P. philippinensis gouldi*, ♀, spermatheca.

0·50 and the maximum 0·64). Maxilla with 8·5 (8–9) lateral and 15·0 (12–18) ventral teeth. Wing length 2·13 (2·01–2·37) mm, R_2/R_{2+3} 1·77 (1·51–2·25), R_1 overlap/R_2 0·12 (0·00–0·18). In a female from Katihar one (short) ascoid on antennal segment 3 has a bifid tip, a feature seen in some ascoids of a few Calcutta flies (S. Das, 1975, in litt.). In two females, outside the series, from Hosur (*H. Trapido*), the ascoid on 4 is 0·39 and 0·70 of the segment length.

India: various. (1) Northern hills. Labrum 0·25 (0·23–0·27) mm, 0·11 (0·10–0·12) length of wing. Antenna 3 = 0·23 (0·21–0·25) mm long, 0·10 (0·10–0·12) length of wing, 1·29 (1·24–1·36) length of 4+5, 0·93 (0·85–1·01) length of labrum, ascoid on 4 = 0·65 (0·64–0·67) length of segment. Maxilla with 10·3 (9–11) and 16·3 (14–18) lateral teeth. Wing length 2·21 (2·08–2·32) mm, R_2/R_{2+3} 1·71 (1·52–1·80), R_1 overlap/R_2 0·10 (0·04–0·11). (2) Near the hills of Kerala. In the single female the labrum is 0·14 as long as the wing, the ascoid on antenna 4 is 0·74 of its length, the maxilla has 12 lateral and 16 ventral teeth, and the wing length is 2·22 mm. The ascoid alone was examined in six flies from Assam (Gologhat) and is 0·62 (0·53–0·67) the length of segment 4. In one female from Mount Abu the figure is 0·46. In these rather peripheral areas the ascoid tends to be long. The ascoid ratio in a fly from Nepal is 0·60.

Sri Lanka. Labrum 0·24 (0·22–0·26) mm long, 0·12 (0·12–0·12) length of wing. Antenna 3 = 0·22 (0·19–0·24) mm long, 0·11 (0·10–0·11) length of wing, 1·24 (1·19–1·31) length of 4+5, 0·90 (0·83–0·94) length of labrum, ascoid on 4 = 0·75 (0·68–0·86) length of segment. Maxilla with 8·9 (8–10) lateral and 13·8 (11–17) ventral teeth. Wing length 2·00 (1·86–2·13) mm, R_2/R_{2+3} 2·00 (1·70–2·31), R_1 overlap/R_2 0·18 (0·14–0·26). The mean ascoid length, R_2/R_{2+3} and R_1 overlap are high. Females are distinguishable from all the east India and south-India-general flies, and all but one of those from the general area of north India.

Thailand. Labrum 0·24 (0·23–0·26) mm long, 0·11 (0·11–0·11) length of wing. Antenna 3 = 0·25 (0·23–0·29) mm long, 0·11 (0·10–0·12) length of wing, 1·12 (1·07–1·20) length of 4+5, 1·04 (0·95–1·08) length of labrum, ascoid on 4 = 0·67 (0·57–0·72) length of segment. Maxilla with 8·7 (8–9) lateral and 12·2 (11–13) ventral teeth. Wing length 2·27 (2·13–2·45) mm, R_2/R_{2+3} 2·12 (1·97–2·65), R_1 overlap/R_2 0·11 (0·07–0·18). The long antenna 3, ascoid and R_2 are close to West Malaysian values, and the wing length is rather high and the number of maxillary ventral teeth low. In South Vietnam the ascoid is rather long (Raynal, 1935*b*).

West Malaysia. Labrum 0·23 (0·22–0·24) mm long, 0·11 (0·10–0·11) length of wing. Antenna 3 = 0·24 (0·22–0·25) mm long, 0·11 (0·10–0·12) length of wing, 1·14 (1·11–1·17) length of 4+5, 1·05 (0·95–1·10) length of labrum, ascoid on 4 = 0·77 (0·69–0·81) length of segment. Maxilla with 8·1 (6–11) lateral and 13·8 (11–17) ventral teeth. Wing length 1·96 (1·74–2·26) mm, R_2/R_{2+3} 1·96 (1·74–2·26), R_1 overlap/R_2 0;16 (0·09–0·24). The labrum is rather short, antenna 3/4+5 low, antenna 3/labrum value high, ascoids long, and R_2/R_{2+3} and R_1 overlap /R_2 values high. All are distinguishable from east India, south-India-general and north-India-general flies; the only one of the latter with a long ascoid has a short antenna 3 and a low antenna 3/labrum value. The West Malaysian form, like the Sri Lanka form, has a long ascoid, but is distinguished from it by a lower labrum/wing length value, a lower antenna 3/4+5 value, and a higher antenna 3/labrum value. In the male of both east India and West Malaysian forms the paired ascoids end at antennal segment 10.

Over-all minima and maxima. The data from all areas give the following result; labrum 0·22–0·27 mm long, 0·10–0·14 length of wing; antenna 3 = 0·19–0·29 mm long, 0·10–0·12 length of wing, 1·11–1·36 length of 4+5, 0·80–1·10 length of labrum; ascoid on 4 = 0·30–0·86 length of segment; maxilla with 6–12 lateral and 11–19 ventral teeth; wing length 1·82–2·45 mm, R_2/R_{2+3} 1·42–2·65. R_1 overlap/R_2 0·00–0·26.

Comments. The specimens examined show similarities between flies from east India and the general areas of south and north India, and they indicate Sri Lanka and West Malaysian forms (with long ascoids and other features) distinct from these. Some specimens from the peripheral areas of India and from north-east Thailand gave intermediate measurements, the differences are small, and little is known of the species in Burma and Thailand. Therefore none of the variants is treated here as a subspecies. There is, however, a striking morphological difference between the short ascoid of the eastern Indian vector of kala-azar and the long ascoid of the non-anthropophilic *P. argentipes* of south-east Asia (Figs 10, 12).

There is nothing to suggest the existence of two species in the *P. argentipes* complex in India, apart from the finding of long and short ascoids at Bombay and at Hosur, but the lack of man-biting *P. argentipes* in the Sagar (Shimoga) area (noted under distribution below) is interesting.

No *P. argentipes* were found in a very large collection from Perak, and there may be some discontinuity of distribution which would suggest a subspecific status for some variants.

Further study of this important species would be instructive, and could well include cytotaxonomy and measurement of more specimens from a wider area, and perhaps the relation of leg measurements to wing length.

MATERIAL EXAMINED.

India. East: Howrah (Calcutta, *S. Das*), 10 ♀; north, general: Aurangabad, Chindwara, Jalna, Karnal, Parel (Bombay, 2), Ranchi, Saharanpur, Sambhar, 10 ♀; south, general: Puligumma, Undi (3), Venkatapuram (2) 6 ♀; various, northern hills: Kathgodam, Simla (3), 4 ♀; various, other: Gologhat, 6 ♀; Kulathupurzha, 1 ♀; Mount Abu, 1 ♀. **Nepal:** Dhunibesi (21.vi.1961, *Y. Shogaki*, 1 ♀). **Sri Lanka:** Pannipitiya (18.iv.1973, *R. Killick-Kendrick*, 10 ♀). **Thailand:** Ban Bon Dan (11.xii.1975, *D. J. Gould*, 6 ♀). **West Malaysia:** Lamir, 10 ♀.

DISTRIBUTION. **Bangladesh:** Dhurmakura (Sinton's notes). **Borneo** (Sabah): Bum Bum Island (Lewis, 1968 : 11); Kalabakan area (Quate & Fairchild, 1961 : 213; Quate & Rosario, 1962 : 791). **Burma:** Rangoon (probably, Sinton, 1928*c* : 311; 1932*a* : 70). **India:** Howrah (as above); Katiher, Kotelanka, Kulathurpuzha, Mount Abu, Nagpur, Nalbari, Ranchi, Simla (BMNH); Calcutta (Basu & Ghosh, 1954*a* : 1955); Aurangabad, Jalna, Patan (Farook & Qutubuddin, 1951 : 85); Kathgodam (14.x.1907, on pony, *J. D. E. Holmes*); Ajmer, Sambhar (Jaswant Singh, 1953); Hoora (Mitra, 1953*b* : 158); Khandwa, Kirki, Mahableshwar, Mahad, Panchgani, Pashan, Poladpur, Wai etc. (Mitra, 1954*b* : 111; 1955 : 82); Hyderabad (near lake, not numerous, Qutubuddin, 1944 : 208); Chamoli area (Rao *et al.*, 1973); Panada Agraharam, Undi, Vellore (6 ♂ on bullock), Vekatapuram (*R. Reuben*); Asansol Kamptee, Palod, Poona, Port Canning (Sinton, 1924*f* : 1041); Golaghat, Lucknow, Puri, Purneah, Rajmahal (Sinton, 1925*c* : 789); Faizabad, Pamban Island, Patna, Sarahanpur (Sinton, 1927*b* : 942); Sanawar (Sinton, 1932*a* : 70); Gauhati, Karnal, Narnaul, Nedumangad, Parbatipur, Rajbari, Trivandrum (Sinton's notes); Sagar (Shimoga) area (Hosur, Kannur, Konehosur, Kumsi, *H. Trapido*; Work *et al.*, 1957; Trapido *et al.*, 1959; no phlebotomines found biting); Bombay (first record, widespread, Young, 1927 : 679). **Indonesia:** Denpasar area (Lewis & Dyce, 1976 : 208). **Laos:** Luang Prabang (Quate, 1962*b* : 256). **Nepal:** Kathmandu area (as above). **Pakistan:** Lahore, Mir Muhammad, Taxla (Lewis, 1967 : 24). **Sri Lanka:** (not plentiful, Smith, 1959 : 17); Balangoda area (*Jun Akiyama*, 12.viii.1977, 4 ♀, 51 ♂ from cow-baited trap net at Kaltota); Peradeniya (Annandale, 1910*a* : 59; 1911*b* : 203; 1911*c* : 319); Delft Island (Carter & Antonipulle, 1949 : 68); Depanama, Kalagoda, Pannipitiya (Theodor, 1938*a* : 269). **Thailand:** Ban Bon Dan, Khao Yai (as above); Chieng Mai (Quate, 1962*b* : 256). **Vietnam (South):** 22 km south of Nha Trang (Quate, 1962*b* : 256); Duc Pho (Raynal, 1936*a* : 360). **West Malaysia:** Kuantan area (box traps near Lamir), Rantan Panjang, Ulu Gombak (Lewis, 1957 : 106); Gua 'Che Yatim (Lewis & Wharton, 1963 : 118); Batu Caves (Quate, 1962*a* : 226; Quate & Fairchild, 1961 : 212).

Sinton (1932*a*) considered that in India *P. argentipes* occurred in a moist climate mainly east and south of the Bombay–Simla line, but with a focus in the Kathiawar Peninsula. Sanawar, at 1220 m, was unusually high for it (Sinton, 1927*g*), but Mitra (1954*a*) found it at nearly 1555 m in the Bombay area. Smith's (1959 : 17) remarks on patchy distribution in India may explain diverse findings in south-east Asia. In 1975 *P. argentipes* was reported from Iran.

Phlebotomus (*Euphlebotomus*) *kiangsuensis* Yao & Wu

(Fig. 17, Map 4)

Phlebotomus sp. Raynal, 1937 : 83 [China; microfilariae in midgut].

Phlebotomus kiangsuensis Yao & Wu, 1938 : 527; 1941*b* : 78. Holotype ♂, CHINA (depository unknown) [not examined]. Conditional name available under ICZN Article 17(8).

Phlebotomus (*Euphlebotomus*) *kiangsuensis* Yao & Wu; Theodor, 1948 : 108; 1958 : 32.

Phlebotomus (*Phlebotomus*) *kiangsuensis* Yao & Wu; Lewis & Wharton, 1963 : 120 [variation]; Cates & Lien, 1970 : 538.

The male differs from that of *P. argentipes* in having a short aedeagus and the central lobe of the paramere thicker than the upper lobe. *P. kiangsuensis*, first found in the Palaearctic Region, has been redescribed by Theodor (1958).

♀ (China, *extra facts*). Hypopharynx with about 18 teeth on each side. Antenna 5 with papilla. Maxilla with eight lateral and 21 ventral teeth, and a dental depth of 0·11 mm.

♂ (China, *extra facts*). Antenna 4 apparently with one ascoid, antenna 5 bearing one normal ascoid, one very small one, and apparently a papilla.

VARIATION. Males from West Malaysia show reduction of proximal ascoids (Lewis & Wharton, 1963) and apparently no papilla on antenna 5. Further study of these delicate structures is desirable.

MATERIAL EXAMINED.
China: Kiangsu (3 ♀, 1 ♂ bred in laboratory, in BMNH collection, evidently originally treated with strong potash which makes papillae difficult to see). **West Malaysia:** 4 ♀, 3 ♂.

DISTRIBUTION. **China:** Kukong area (Chen & Hsu, 1955 : 302). **Taiwan:** Taitung area (3 ♀, Cates & Lien, 1970 : 539). **West Malaysia:** Batu Cave (5.ix.1959, *N. E. McClure*); Betis (Lewis & Wharton, 1963 : 120).

P. kiangsuensis and two other species of *Euphlebotomus* occur in Palaearctic China.

Phlebotomus (*Euphlebotomus*) *philippinensis* Manalang

Phlebotomus philippinensis Manalang, 1930*b* : 175.

The male differs from that of *P. argentipes* in having longer eyes (as in the female) and a deeper paramere, and in the relative lengths of the main and middle lobes of the paramere.

Quate & Rosario (1962) gave a recent description and indicated that sympatric females of the two species would be difficult to separate and that records should be confirmed by means of males; also that *P. philippinensis* is smaller, and has less developed cibarial spicules, a stronger chitinous arch and slightly longer antenna 3.

Phlebotomus (*Euphlebotomus*) *philippinensis gouldi* Lewis **subsp. n.**

(Figs 18–21, Map 4)

P. p. gouldi has higher antenna 3/wing length and antenna 3/4+5 values in both sexes than does *P. p. philippinensis*, antenna 3 in the female reaches beyond the labrum, the maxillary ventral tooth number and dental depth are greater, wing length is greater in the male, R_1 overlap is longer in both sexes, and the style is rather long and narrow.

♀. Eye 0·43 length of head. Labrum 0·22 (0·22–0·23) mm long, 0·11 (0·11–0·11) length of wing. Antenna 3 extending beyond labrum, 0·34 (0·31–0·36) mm long, 0·17 (0·17–0·18) length of wing, 1·24 (1·23–1·26) length of 4+5, 1·42 (1·39–1·45) length of labrum, two ascoids on segments 3–15, that on 4 = 0·74 length of segment, papilla on 5. Maxilla with seven lateral and 12 ventral teeth and a dental depth of 0·06 mm, palpal ratio 10 : 24 : 34 : 19 : 36. Wing length 1·98 (1·91–2·05) mm, 3·1 times width, R_2/R_{2+3} 1·77 (1·70–1·84), R_1 overlap/R_2 0·13 (0·08–0·17). Spermathecae delicate and indistinctly wrinkled or segmented, with large end-segment, individual ducts delicate and common duct thick-walled.

♂. Eye 0·42 length of head. Labrum 0·20 mm long, 0·10 length of wing. Antenna 3 = 0·40 mm long, 0·20 length of wing, 1·21 length of 4+5, 2·02 length of labrum; two ascoids on segments 3–13, one on 14 and 15, that on 4 = 0·58 length of segment. Wing length 1·95 mm, 3·4 times width, R_2/R_{2+3} 1·58, R_1 overlap/R_2 0·13. Style 0·61 length of coxite, 3·6 times as long as width (basad of middle spines).

MATERIAL EXAMINED.
Holotype ♀, **Thailand:** Ban Bon Dan, 11.xii.1975 (*D. J. Gould*), light trap with CO_2 in evergreen and deciduous tropical forest (BMNH).

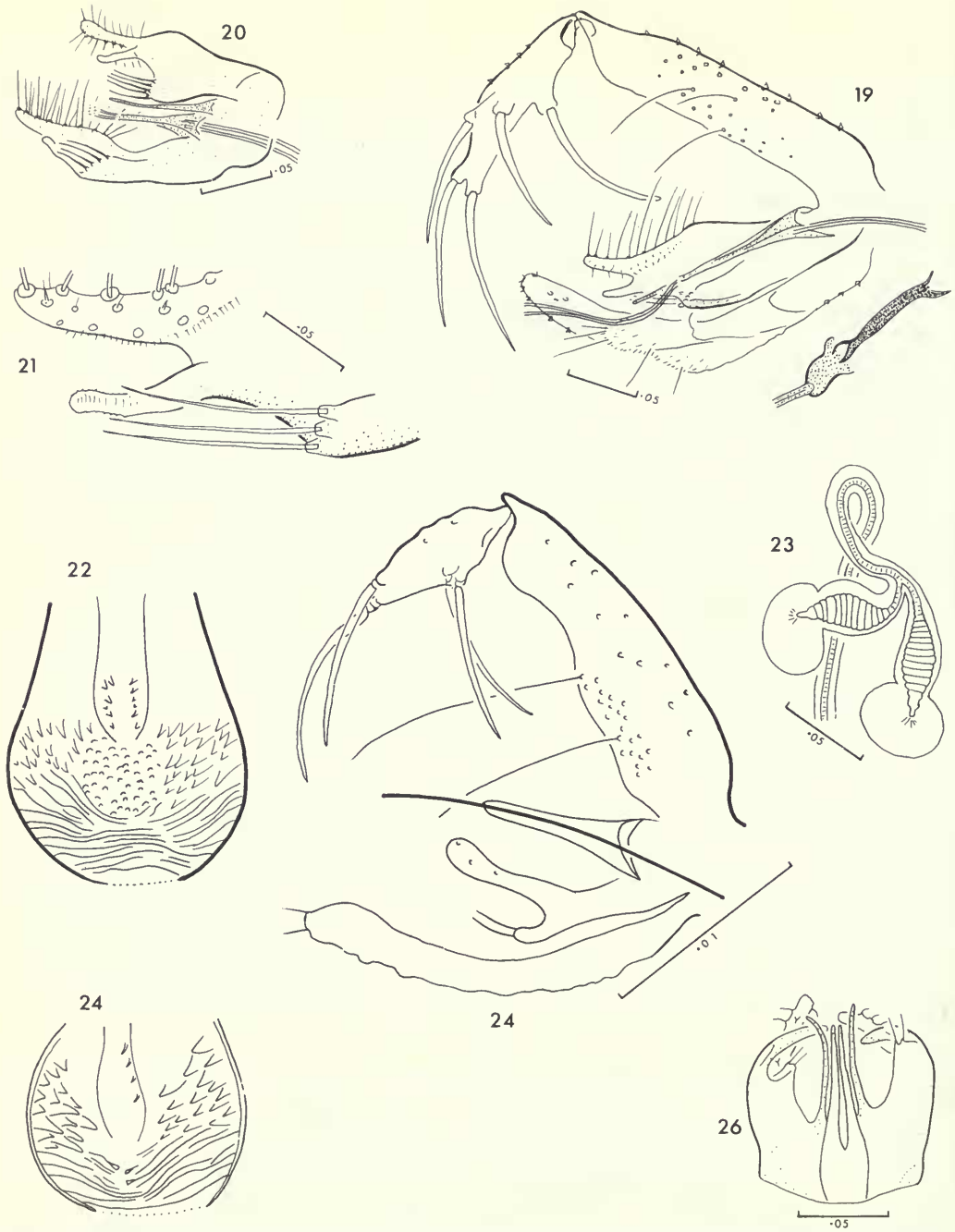
Paratypes. Same data, 10 and 11.xii.1975, 1 ♀, 1 ♂ (BMNH).

DISTRIBUTION. **Thailand:** Ban Bon Dan (as above); Khao Yai (25.iii.1976, *D. J. Gould*, 700 m, rain forest, 1 ♀).

Phlebotomus (*Euphlebotomus*) *philippinensis philippinensis* Manalang

(Map 4)

Phlebotonus philippinensis Manalang, 1930*b* : 175; Sinton, 1931*d* : 104. Syntypes ♀ ♂, PHILIPPINES (destroyed according to Quate & Rosario, 1962 : 789) [not examined].
Phlebotomus (*Euphlebotomus*) *philippinensis* Manalang; Theodor, 1948 : 108.
Phlebotomus (*Phlebotomus*) *philippinensis* Manalang; Quate, 1965 : 20; Quate & Rosario, 1962 : 789.



Figs 19–26 *Phlebotomus* species. 19–21, *P. philippinensis gouldi*, ♂, terminalia, aedeagus and parameres, and tip of paramere. 22–26, *P. hoepplii*, after Tang & Maa: (22) ♀, pharynx; (23) ♀, spermatheca; (24) ♂, pharynx; (25) ♂, terminalia; (26) ♂, aedeagus and parameres.

♀ (*extra facts*). Eye 0·38 length of head. Labrum 0·23 mm long, 0·13 length of wing. Hypopharynx with 16 teeth on each side. Antenna 3 not reaching tip of labrum, 0·24 mm long, 0·13 length of wing, 1·15 length of 4+5, 1·04 length of labrum, ascoid on 4 about 0·8 length of segment, papilla present on 5. Maxilla with seven lateral and 17 ventral teeth and a dental depth of 0·20 mm. Wing length 1·81 mm, R_2/R_{2+3} 1·77, R_1 apex/R_2 0·22. Spermatheca with faint pit and knob; common duct with thick walls.
♂ (*extra facts*). Eye 0·41 length of head. Labrum 0·16 (0·15–0·16) mm long, 0·09 (0·09–0·09) length of wing. Antenna 3 = 0·26 (0·24–0·28) mm long, 0·16 (0·15–0·16) length of wing, 1·16 (1·10–1·22) length of 4+5, 1·67 (1·63–1·71) length of labrum, ascoid on segment 4 = 0·74 length of segment, papilla present on 5. Wing length 1·66 (1·55–1·76) mm, R_2/R_{2+3} 1·62 (1·38–1·86), R_1 overlap/R_2 0·51 (0·08–1·04). Lower lobe of paramere a broad flange extending mesally and bearing four or five spines. Style 0·54 length of coxite, 4·1 as long as width (basad of middle spines).

Material examined.
Philippines: Imus, 1 ♂; La Mesa, 1 ♀; Silang, 1 ♂.

Distribution. **Philippines:** Novaliches (Manalang, 1930*b* : 175); Cotabato, Eran area, Los Arcos etc. (Quate, 1965 : 20); Imus, La Mesa, Silang (Quate & Rosario, 1962 : 791).

Subgenus *ANAPHLEBOTOMUS* Theodor

Phlebotomus subgenus *Anaphlebotomus* Theodor, 1948 : 99; Hennig, 1972 : 53. Type-species: *Phlebotomus stantoni* Newstead, 1914, by original designation.

The coxite has no lobe and the style bears four spines. It is represented in the Region by three species which, between them, cover a wide area.

Phlebotomus (*Anaphlebotomus*) *colabaensis* Young & Chalam

(Map 5)

Phlebotomus colabaensis Young & Chalam, 1927 : 859; Sinton, 1932*a* : 59; 1933*d* : 226 [♀]; 1933*e* : 418 [♂]. Holotype ♂, India (Central Research Institute, Kasauli) [not examined].
Phlebotomus (*Anaphlebotomus*) *colabaensis* Young & Chalam; Theodor, 1948 : 108; Lewis, 1967 : 24.

The paramere is bilobed and the style has four spines. The following notes are based on Young & Chalam and on Sinton, and study of one fly.

♀. Labrum 0·30 mm long, 0·15 length of wing. Hypopharynx with about 19 teeth on each side. Maxilla with 11 lateral and 23 ventral teeth and a dental depth of 0·11 mm. Antenna 3 = 0·29 mm long, 0·14 length of wing, 1·18 length of 4+5, 0·97 length of labrum, ascoid on segment 3 = 0·61 length of segment, papilla on 5. Palpal segment 3 with sensilla grouped near middle. Thoracic sternal lobe broad. Spermatheca not markedly carrot-shaped, with small end-segment; duct long, about four times length of spermatheca, joining common duct.
♂. Antenna 3 = 0·22 mm long, 1·1 length of 4+5. Palpal formula 1–4–2–(3–5), ratio 10 : 27 : 40 : 20 : 40. Wing length 1·47 mm, width 0·41 mm, R_2/R_{2+3} 1·4, R_1 overlap/R_2 0·1. Hind tibia 1·72 length of femur. Aedeagus pyramidal and sharply pointed. Paramere bilobed, lower lobe bare and mammiform. Style about 3·9 times as long as wide, with four spines of nearly equal thickness, at 0·23, 0·57, 0·73 and tip.

Material examined.
India: Kulathurpuzha, 1 ♀.

Distribution. **India:** Kulathurpuzha (BMNH); Sambhar (Jaswant Singh, 1933); Hyderabad (near river, Qutubuddin, 1944 : 208); Bombay (Sinton, 1928*c* : 310; Young & Chalam, 1927 : 49); Bissamcuttack (Sinton, 1932*a* : 71). **Pakistan:** Lahore (Lewis, 1967 : 24).

Phlebotomus (*Anaphlebotomus*) *hoepplii* Tang & Maa

(Figs 22–26, Map 5)

Phlebotomus hoepplii Tang & Maa, 1945 : 25, Holotype ♂, China (T. Maa's collection) [not examined].

The male differs from that of *P. stantoni* in having the spine near the aedeagus much longer than it.

The following description is adapted from the original for which five flies of each sex were used for most measurements.

♀. Pharynx about three times as long as wide, armature with faint transverse and slightly oblique lines; anteriorly lines are more developed and there are lateral backward-pointing teeth and medially some small ones. Antenna 3 = 0·25 (0·24–0·27) mm long, 1·2 (1·1–1·3) length of 4+5, two ascoids on segments 3–15, that on 4 almost as long as segment and reaching beyond its tip. Palpal formula 1–4–2–3–5, ratio 10 : 31 : 44 : 17 : 34. Wing length 1·86 (1·75–2·07) mm, width 0·55 (0·48–0·61) mm, R_1/R_{2+3} 2·1 (1·8–2·3), R_1 overlap/R_2 about 0·25. Hind tibia 1·84 (1·77–1·91) length of femur. Spermatheca fusiform with small head and short neck; roughly 14 segments figured; duct shorter than spermatheca; common duct long.

♂. Cibarium unarmed. Pharynx about four times as long as wide, armature with a series of oblique ridges radiating from the middle, and antero-lateral sharp teeth pointing postero-medially. Antenna 3 = 0·27 (0·26–0·28) mm long, 1·26 (1·23–1·33) length of 4+5; two ascoids on segments 3–15, that on 4 about 0·83 length of segment and reacing its tip. Wing length 1·68 (1·58–1·75) mm, width 0·50 (0·46–0·53) mm. Hind tibia 0·20 length of leg. Aedeagus with rounded tip, and a long spine on each side. Paramere with three lobes, the small ventral one usually bearing three curved spines. Coxite long and slender with a large group of long hairs. Style spindle-shaped with four spines, the two proximal ones being more slender, at 0·48, 0·53, 0·91 and tip. Cerci narrow and club-like distally, not figured.

DISTRIBUTION. **China:** Kuang-chou (Chen & Hsu, 1955 : 302); Masha, Shao-wu (Tang & Maa, 1945 : 25).

Phlebotomus (*Anaphlebotomus*) *stantoni* Newstead

(Figs 27–29, Map 5)

Phlebotomus stantoni Newstead, 1914 : 190; Sinton, 1923*a* : 749; 1928*c* : 311; 1931*d* : 99, 104; 1933*d* : 226; Raynal & Gaschen, 1934*d* : 670 [♂]; Raynal, 1935*b* : 237 [♂]; 1936*a* : 357; Theodor, 1938 : 269; Yao & Wu, 1940 : 773; 1941*b* : 74; Tang & Maa, 1945 : 29. Holotype ♀, WEST MALAYSIA (BMNH) [examined].

Phlebotomus (*Phlebotomus*) *stantoni* Newstead; Parrot, 1946 : 67; Parrot & Clastrier, 1952 : 154; Quate & Fairchild, 1961 : 205; Quate, 1962 : 256.

Phlebotomus (*Anaphlebotomus*) *stantoni* Newstead; Theodor, 1948 : 99.

Phlebotomus maynei Sinton, 1930*b* : 195. Holotype ♂, INDIA (BMNH) [examined]. [Synonymized by Raynal & Gaschen, 1934*d* : 670.]

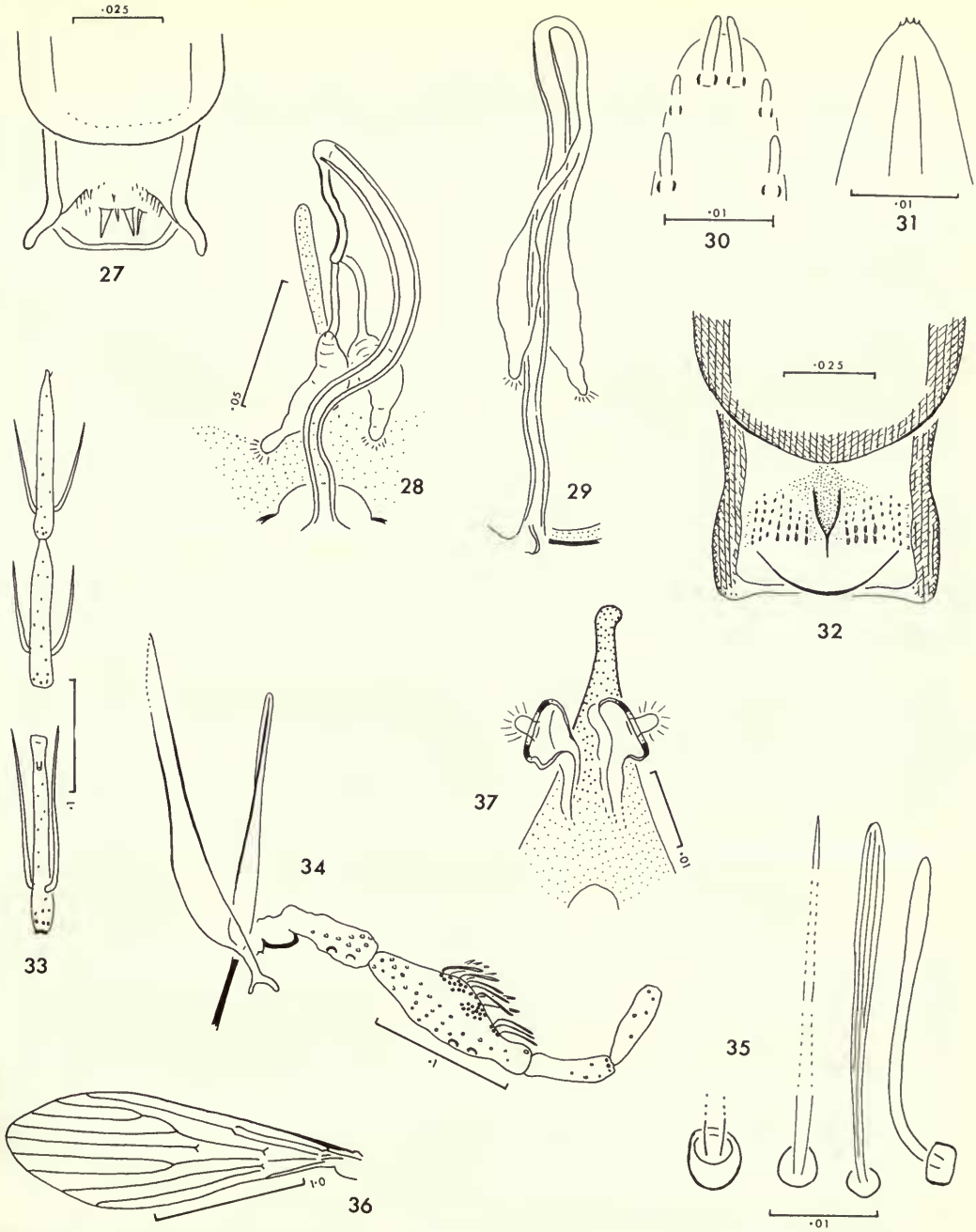
Phlebotomus (*Phlebotomus*) *maynei* Sinton; Parrot, 1940 : 310; Lewis, 1967 : 27; 1974*b* : 190.

The female has individual spermathecal ducts longer than the spermathecae and a very long thick-walled common duct. In the male the rods near the aedeagus are not longer than it. Most of the following description is adapted from those of Newstead, Parrot & Clastrier and Sinton (1923*a*; 1931*d*; 1933*d*), and based partly on the holotype. The species was figured by these authors and by Quate.

Quate & Fairchild (1961) mention a pigment patch, but Raynal (1935*b*), Raynal & Gaschen (1931*d*), Sinton (1931*d*) and Yao & Wu (1940) state that there is none, and I have not found one.

♀. Labrum 0·23–0·26 mm long. Cibarium with about 15 pointed denticles of various lengths, irregularly arranged, the two or three median ones longer and stouter than the others. Pharynx two or less times wider posteriorly than anteriorly, with numerous posterior transverse folds, parallel and concentric, the hinder ones bearing short fine spicules; before the folds are numerous long strong pointed spines in a convex crescent. Hypopharynx with about 16 teeth on each side. Antenna 3 = 0·27–0·30 mm long, longer than 4+5, 1·1 length of labrum, two long ascoids on segments 3–15, those on 4 about 0·8 length of segment and reaching to or beyond its tip. Maxilla with nine lateral and 18 ventral teeth and a dental depth of 0·08 mm. Palpal formula 1–4–2–3–5 or 1–4–2–(3–5), ratio 10 : 29 : 46 : 19 : 50. Wing length 1·9 mm, width 0·58–0·61 mm, R_2/R_{2+3} 1·6–1·7, R_1 overlap 0·08–0·12 mm. Hind legs 3·55–3·75 mm long. Spermatheca fusiform, with 15 or 16 rings, neck thick and short, head more or less oblong, duct striated, common duct very long, about 1·5 length of individual ones, with thick wall.

♂. This was described mainly by Raynal & Gaschen (1935*d*) and Raynal (1935*b*).



Figs 27–37 *Phlebotomus* species. 27–29, *P. stantoni*, ♀ (from Java), cibarium and spermathecae. 30–37, *P. teshi*, ♀: (30, 31) tips of labrum and hypopharynx; (32) cibarium; (33) antennal segments 4, 15 and 16; (34) mandible and maxilla; (35) two hairs, a scale and a sensillum from palpal segment 3; (36) wing; (37) spermathecae.

MATERIAL EXAMINED.
Java: Djakarta (see under *S. perturbans*). **West Malaysia:** Gunong Besout Forest Reserve, 1 ♀ (hypopharynx and maxilla blade).

DISTRIBUTION. **China:** Hainan (Leng, 1964 : 127); Mencheong (Yao & Wu, 1940 : 97); Aihsien, Paoting (Yao & Wu, 1941*b* : 76); Mang-shih (Yao & Wu, 1941*c* : 79). **India:** Saharanpur (Sinton, 1930*b* : 195); Golaghat (Sinton, 1932*c* : 225); Sagar area (*H. Trapido*). **Java:** Jakarta (as above). **Laos:** Luang Prabang (Parrot and Clastrier, 1952 : 153); Ventiane (Quate, 1962*b* : 256); Thahkek (Raynal, 1935*b* : 241). **Sri Lanka:** Kalgoda (Theodor, 1938 : 269). **Thailand:** Bangkok (Raynal & Gaschen, 1934*a* : 532). **Vietnam (North):** Bac Muc, Coc Leu, Ha Giang, Lam, Nao Phu, Pho Moi, Phu Doan, Vinh Thuy, Yen Lay (Raynal, 1935*b* : 241); Hai Duong (Raynal, 1936 : 250); Cho Gan (Raynal & Gaschen, 1934*a* : 531). **Vietnam (South):** 22 km south of Nah Trang (Quate, 1962*b* : 256); Kim Son (Raynal, 1935*b* : 241). **West Malaysia:** Kuala Lumpur, Rantau Panjang light trap (Lewis, 1957 : 166); Batu (Quate, 1962*a* : 226).

Raynal (1936*a* : 350, 357) reported that *P. stantoni* seemed rare in India and was common in Indo-China, being abundant between latitudes 20° and 30°.

UNGROUPED

Phlebotomus newsteadi Sinton

(Map 5)

Phlebotomus newsteadi Sinton, 1926 : 559; 1928*a* : 589 [♀]; 1932*a* : 58; 1933*e* : 418; Theodor, 1948 : 418. LECTOTYPE ♂, INDIA: Kasauli; labelled 'Type ♂ . . . Rabbit houses, Pasteur Institute, Kasauli, Punjab, 28/8/25' (BMNH), here designated [examined].

In the female the pharyngeal armature is well developed and the spermatheca is moniliform. In the male there are two spines near the aedeagus, the paramere ends like a crochet-hook, three of the spines on the style are apical or subapical, and the haltere is flattened.

Theodor placed this species provisionally in *Euphlebotomus*, but inspection of the lectotype (below) suggests that it is outside the subgenera.

MATERIAL EXAMINED.
India: Kasauli, 1 ♂, as above.

DISTRIBUTION. **India:** Kasauli, Kurseong (Sinton, 1928*c* : 310).

P. newsteadi, like *P. major*, is a hill species (Sinton, 1932*a*).

Subgenus *IDIOPHLEBOTOMUS* Quate & Fairchild

Phlebotomus subgenus *Idiophlebotomus* Quate & Fairchild, 1961 : 208; Theodor, 1965 : 176; Lewis, 1973 : 162; Lewis & Lane, 1976 : 53; Abonnenc & Léger, 1976 : 76. Type-species: *Phlebotomus asperulus* Quate & Fairchild, 1961, by original designation.
Idiophlebotomus Quate & Fairchild; Abonnenc, 1972 : 69, 75.

The cibarium has teeth, the pharynx is unarmed and the palp short. A pair of rods is associated with the genital filaments. All the species are Oriental and most occur in caves. The redefinition by Lewis & Lane should be altered as follows.

Pigment patch absent in all species but one. Antenna 3 with sub-basal swelling and beyond it a slight depression bearing non-spatulate sensilla.

Phlebotomus (*Idiophlebotomus*) *asperulus* Quate & Fairchild

(Map 5)

Phlebotomus (*Idiophlebotomus*) *asperulus* Quate & Fairchild, 1961 : 208; Lewis & Lane, 1976 : 54. Holotype ♂, WEST MALAYSIA (BPBM) [not examined].

The female has a cibarial median rod with large serrations, and the male has an apical spine on the style which is markedly expanded.

DISTRIBUTION. **West Malaysia:** Betis (Lewis & Wharton, 1963); Kuala Lumpur (Quate & Fairchild, 1961; McClure *et al.*, 1967 : 422).

Phlebotomus (*Idiophlebotomus*) *erebicolus* Quate

(Map 5)

Phlebotomus (*Idiophlebotomus*) *erebicolus* Quate, 1965 : 22; Lewis & Lane, 1976 : 57. Holotype ♂, PHILIPPINES (BPBM) [not examined].

The female has a cibarial median rod and a few granulose spicular teeth, and the male has three spines on the style.

DISTRIBUTION. **Philippines:** Mainit Lake (Quate, 1965).

Phlebotomus (*Idiophlebotomus*) *frondifer* Lewis & Lane

(Map 5)

Phlebotomus (*Idiophlebotomus*) *frondifer* Lewis & Lane, 1976 : 57. Holotype ♂, WEST MALAYSIA (BMNH) [examined].

The female has a median rod in the cibarium and very long parallel teeth, and the male has a leaf-like aedeagus and four spines on the style.

DISTRIBUTION. **West Malaysia:** Gunong Besout Forest Reserve (Lewis & Lane, 1976).

Phlebotomus (*Idiophlebotomus*) *pholetor* Quate & Fairchild

(Map 5)

Phlebotomus (*Idiophlebotomus*) *pholetor* Quate & Fairchild, 1961 : 210; Lewis & Lane, 1976 : 57. Holotype ♂, BORNEO: Sabah (BPBM) [not examined].

The female has a cibarial median rod and short teeth, and the male has five spines on the style.

DISTRIBUTION. **Borneo** (Sabah): Gomantong (Quate & Fairchild, 1961). **Philippines:** Eran area (Quate, 1965 : 24).

Phlebotomus (*Idiophlebotomus*) *sejunctus* Quate

(Map 5)

Phlebotomus (*Idiophlebotomus*) *sejunctus* Quate, 1965 : 20. Holotype ♀, PHILIPPINES (BPBM) [not examined].

The female has a cibarium with no median rod and very long anterior teeth.

DISTRIBUTION. **Philippines:** Mainit Lake (Quate, 1965).

Phlebotomus (*Idiophlebotomus*) *stellae* Quate

(Map 5)

Phlebotomus (*Idiophlebotomus*) *stellae* Quate, 1965 : 20; Lewis & Lane, 1976 : 59. Holotype ♂, PHILIPPINES (BPBM) [not examined].

The female has no median cibarial rod and very small teeth, and the male has five spines on the style.

DISTRIBUTION. **Philippines:** Minglanille (Quate, 1965).

Phlebotomus (*Idiophlebotomus*) *teshi* Lewis **sp. n.**

(Map 5)

The female differs from other species of *Idiophlebotomus* in having a cibarial pigment patch and a median large short tooth.

♀. Labrum 0·20 mm long, 0·08 length of wing, with two apical sensilla prominent, and reduced adoral sensilla. Cibarium with chitinous arch far back, a very marked hind bulge, a large pigment patch, a median very thick tooth and, on each side, about seven longitudinal rows of four to six teeth. Pharynx with bulge twice as wide as fore part, and narrow hind opening with minute spicules. Hypopharynx smooth with a few spicules at tip. Antenna 1 and 2 large, segment 3 = 0·58 mm long, 0·24 length of wing, 1·66 length of 4+5, 2·94 length of labrum, two strong ascoids on segments 3–16, that on 4 = 0·87 length of segment and reaching next one, a papilla on 3–5. Mandible pointed, with small teeth and no submedian pit. Maxilla toothless and shorter than mandible; palpal ratio 10 : 14 : 41 : 19 : 20; with a rather diffuse patch of slightly club-shaped sensilla. Thorax pale, without pleural hairs, inter-precoxal lobes broad. Wing length 2·40 mm, 2·9 times width, R_2/R_{2+3} = 2·92, R_1 apex/R_2 = 0·54. Leg ratios: fore (1·04 mm), 10 : 12 : 9; mid (0·96 mm), 10 : 17 : 9; hind (1·00 mm), 10 : 19 : 14. Abdominal tergites 2–6 (as in *P. frondifer* Lewis & Lane) with scattered erect hairs but few in mid line in hind halves of segments. Each spermatheca having a short capsule with a very thick wall near the head, ducts thin-walled and indistinct; furca with broad fore arm.

This species is named in appreciation of Dr R. B. Tesh's studies of sandfly fever viruses and Malaysian sandflies.

MATERIAL EXAMINED.
Holotype ♀, **Nepal:** Pokhara, 18–27.ix.1965 (*L. Quate*), 910 m, Malaise trap, a little red blood in abdomen (BPBM).

Phlebotomus (*Idiophlebotomus*) *tubifer* Lewis & Lane

(Map 5)

Phlebotomus (*Idiophlebotomus*) *tubifer* Lewis & Lane, 1976 : 59. Holotype ♀, INDIA (BMNH) [examined].

The female has a median cibarial rod and teeth on radiating lines. The male has been discovered by Dr G. B. Modi (1972, in letter).

DISTRIBUTION. **India:** Mahableshwar (Lewis & Lane, 1976).

Genus *SERGENTOMYIA* França & Parrot

Phlebotomus subgenus *Newsteadia* França, 1919 : 148. Type-species: *Hebotomus minutus* Rondani, 1843, by subsequent designation of França, 1920 : 234. [Homonym of *Newsteadia* Green, 1902.]
Phlebotomus subgenus *Sergentomyia* França & Parrot, 1920 : 699; Fairchild, 1951 : 12; Quate, 1964 : 249. [Replacement name for *Newsteadia* França.]
[*Neophlebotomus* França & Parrot, 1920 : 699. Incorrectly treated as synonym, now recognized as subgenus.]
Phlebotomus subgenus *Prophlebotomus* França & Parrot, 1921 : 281. Type-species: *Hebotomus minutus* Rondani, 1843 : 265, by monotypy. [Synonymized by Theodor, 1948 : 88.]
Sergentomyia França & Parrot; Theodor, 1948 : 100; 1958 : 33; 1965 : 179; Perfil'ev, 1968 : 295.
Sergentomyia subgenus *Sergentomyia* França & Parrot; Theodor, 1948 : 101; 1958 : 36; Kirk & Lewis, 1951 : 409; Perfil'ev, 1968 : 214, 298; Abonnenc, 1972 : 69.

The cibarium has a definite row of teeth and a pigment patch. The style of the male has four spines and an accessory seta. The genus is widely distributed in the Old World tropics and subtropics.

In early papers on Indian sandflies, mainly before 1928, '*P. minutus*' refers to one or more species of the genus *Sergentomyia*, particularly the common *S. babu*. This was because the taxonomic importance of cibarial teeth and spermathecae was unknown till 1926, and (Sinton, 1928*b* : 185) because *S. babu* was wrongly thought by Annandale (1911*b*) to be the Palaearctic *S. minuta* (Parrot).

The *musai*-group

This group is here proposed for the single species *S. musai*.

Sergentomyia musai Lewis **sp. n.**

(Figs 38–50, Map 6)

The cibarium of the female has 12 long thread-like teeth and no fore teeth or pigment patch.

♀. Labrum 0·22 mm long, 0·14 length of wing, with only two subapical sensilla and small adorals. Cibarium with 12 long thread-like teeth, no pigment patch and a weak arch; salivary pump inapparent. Pharynx damaged but showing lines and denticles. Hypopharynx with short row of nine teeth on each side. Antenna 3 = 0·27 mm long, 0·17 length of wing, 1·01 length of 4+5, 1·20 length of labrum, two ascoids on segments 3–15, that on 5 being 0·9 length of segment, papilla present on 5; hairs directed outward and forward. Maxilla with no lateral teeth, 37 small but stout ventrals, and a dental depth of 0·05 mm; palpal ratio 10 : 25 : 35 : 19 : 35; segment 3 with a few scattered spatulate sensilla, hair-like at some angles. Scutum and pleuron pale, mesepisternum without hairs. Wing 1·58 mm long, 3·04 as long as wide, R_2/R_{2+3} 1·95, R_1 overlap/R_2 0·66. Leg ratios: fore (0·62 mm), 10 : 11·5 : –; mid (0·63 mm), 10 : 12·8 : 7·7; hind (0·67 mm), 10 : 14·4 : –. Abdominal tergites 2–6 with many erect hairs and a few recumbent ones near middle line. Spermatheca not fully visible but apparently simple.

Comment. This very unusual species differs from most *Sergentomyia* in its two labral subapical sensilla, shape of cibarial teeth, hypopharynx, papilla on antenna 5, maxillary dentition, short palpal segments 4 and 5 and nature of sensilla, and many abdominal erect hairs. *S. musai* possesses several features of both *Phlebotomus* and *Sergentomyia*, and is placed, for the present, among the ungrouped species of the latter. The hypopharynx and abdominal hairs of *S. musai* may indicate relationship to the subgenus *Parvidens* Theodor & Mesghali. It is named after Musa bin Long of the Arbovirus Unit, Kuala Lumpur, who collected many sandflies in West Malaysia.

Material examined.
Holotype ♀, **Borneo:** Sabah, Kalabakan area, 29.x.1962 (*K. J. Kuncheria*), forest camp 19 km north of Kalabakan, 60 m (BPBM).

Subgenus *SERGENTOMYIA* França & Parrot

Sergentomyia subgenus *Sergentomyia* França & Parrot; Theodor, 1948 : 101; 1958 : 36; Perfil'ev, 1968 : 298.

The spermatheca is tubular with smooth sides and a wide duct, and the aedeagus is thick. The subgenus is represented in the west of the Region.

Sergentomyia (*Sergentomyia*) *dentata* (Sinton)

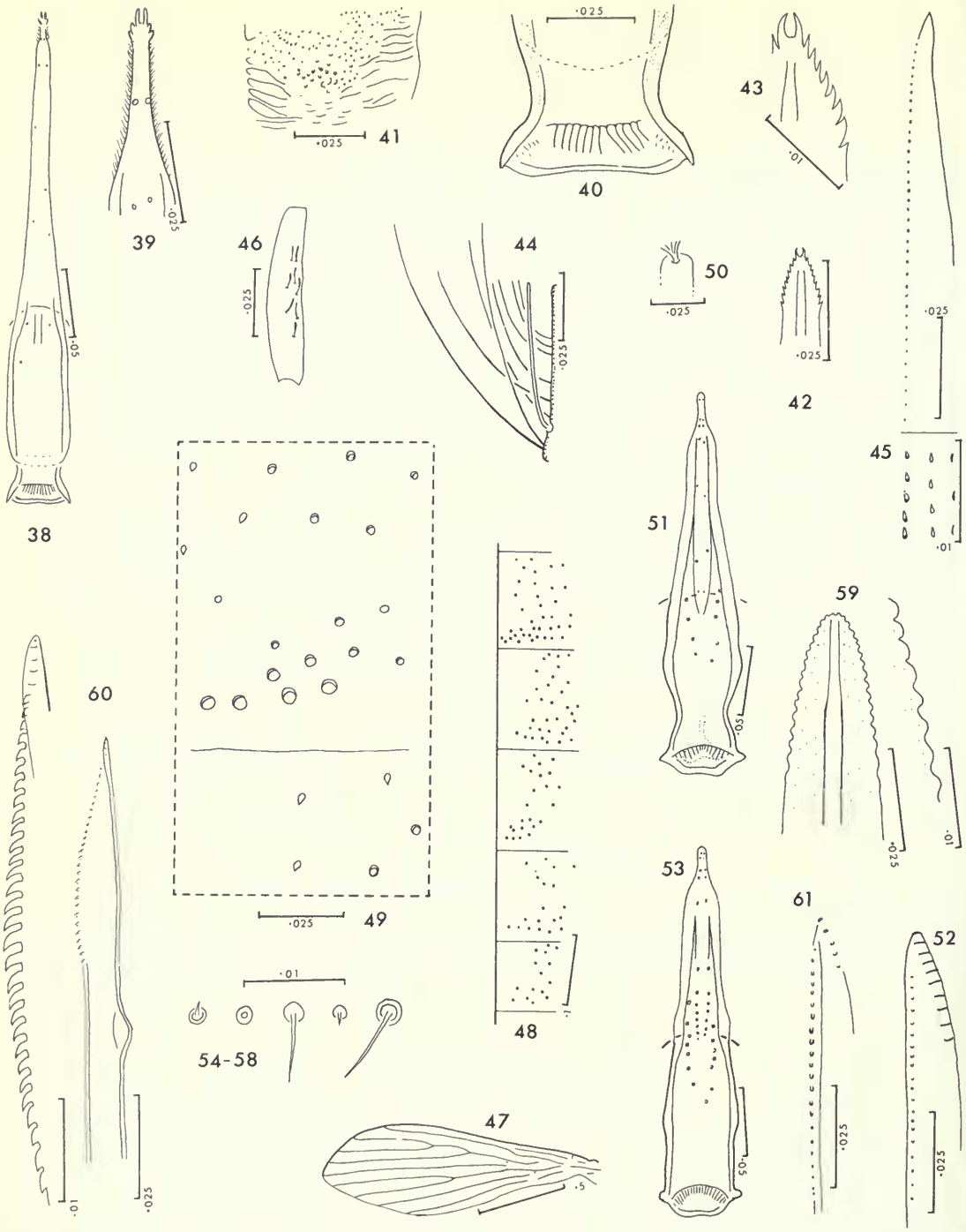
(Figs 51, 52, Map 6)

Phlebotomus dentatus Sinton, 1933*a* : 869; 1933*d* : 228. Lectotype ♀, Pakistan (BMNH), designated by Lewis, 1967 : 25 [examined].
Sergentomyia (*Sergentomyia*) *dentata* (Sinton); Theodor, 1958 : 39 [in part]; Lewis, 1967 : 25; 1974*b* : 190.

In the cibarium of the female about four teeth on each side are much larger than the middle ones.

♀ (*extra facts*). Hypopharynx with distinct low rounded teeth. Mandible (as in *S. punjabensis*) with rather blunt tip, and teeth large except near tip. Maxilla with ten broad lateral teeth, 20 distinct ventrals, and a dental depth of 0·08 mm.

Material examined.
Pakistan: Landi Kotal.



Figs 38–61 *Sergentomyia* species. 38–50, *S. musai*, ♀: (38) labrocibarium; (39) tip of labrum; (40) cibarium; (41) part of pharynx; (42, 43) tip of hypopharynx; (44) one side of antenna 6; (45) maxilla; (46) palp segment 3; (47) wing; (48, 49) sockets of erect hairs on abdominal tergites 2–6 and on parts of 3 and 4; (50) tip of spermatheca. 51, 52, *S. dentata*, ♀ (from Landi Kotal), labrocibarium and maxilla. 53–61, *S. punjabensis*, ♀: (53) labrocibarium; (54–58) subapical sensillum no. 2, adoral sensilla nos 1, 4 and 7, cibarial sensillum no. 5; (59) hypopharynx; (60) mandible; (61) maxilla.

DISTRIBUTION. **Pakistan:** Gwadi, Landi Kotal, Peshawar, Rawalpindi (Lewis, 1967 : 25); Quetta (Sinton, 1933*a* : 869).

Sergentomyia (*Sergentomyia*) *punjabensis* (Sinton)

(Figs 53–61, Map 6)

Phlebotomus antennatus Newstead; Sinton, 1927*e* : 31; 1933*e* : 421.
Phlebotomus minutus var. *antennatus* Newstead; Sinton, 1924*a* : 812; 1932*a* : 61 [♀]; 1933*e* : 421; Qutubuddin, 1952 : 79.
Phlebotomus punjabensis Sinton, 1933*e* : 421. Conditional name available under ICZN Article 17(8). No type-data (INDO-PAKISTAN, specially Punjab) [not examined].
Sergentomyia (*Sergentomyia*) *punjabensis* (Sinton); Theodor, 1948 : 109; Lewis, 1967 : 27; 1974*b* : 190.
Sergentomyia punjabensis (Sinton); Qutubuddin, 1951 : 36.
Phlebotomus antennatus var. *deccanensis* Qutubuddin, 1952 : 79. Syntype ♂, INDIA (depository unknown) [not examined]. [Synonymized by Lewis, 1967 : 27.]

The pharynx of the female is very wide posteriorly, and its armature has a deep acute hind notch and many teeth of which the posterior ones are very small. The cibarial teeth are nearly equal in size.

♀ (*extra facts*). Labrum with adoral sensilla not differentiated into two groups, most of them about as large as cibarials, some of each with long processes. Hypopharynx with distinct rounded main teeth, most nearly twice as long as high. Mandible with large main teeth. Maxilla with strong teeth, five laterals and 22 ventrals, and a dental depth of 0·07 mm.

MATERIAL EXAMINED.
Pakistan: Shahzada (near Lahore).

DISTRIBUTION. **India:** Hardwar, Khandwa, Nagpur, Patiala (BMNH); Aurangabad (*V. Dhanda*); Ajmer area, Jaipur, Jalor, Kota area, Sirohi area (Kaul *et al.*, 1973 : 533); Jammu (Mitra & Roy, 1953*a* : 324); Hyderabad (Qutubuddin, 1944 : 208); Vellore (*R. Reuben*); Bikaner (Sharma *et al.*, 1973*c*); Bhavnagar, Bissamcuttack, Bombay, Calcutta, Chandigarh, Cochin area, Delhi, Itaunia, Junagadh, Kamptee, Karnal, Madras, Parbitapur, Pinjaur, Pipariya, Pipli, Secunderabad, Singarama (Sinton's notes, as *P. antennatus*); Panchgani, Wai area (*H. Trapido*). **Pakistan:** Dehra Ismail Khan, Jhelum, Khanki, Kohat area, Lahore, Peshawar, Rawalpindi, Said Pur (Lewis, 1967 : 28); Bannu, Lyallpur, Sargodha, Tank (Sinton's notes). **Sri Lanka:** Delft Island (Carter & Antonipulle, 1949 : 68).

Sinton (1932*a*) reported that '*P. minutus* var. *antennatus*' (=*S. punjabensis*) had a more general distribution over the Indo-Pakistan plains than did '*P. minutus*' (=*S. theodori*).

Sergentomyia (*Sergentomyia*) *theodori* (Parrot)

[*Phlebotomus minutus* (Rondani, 1840 : 263); Adler & Theodor, 1926 : 403; Sinton, 1932*a* : 73; 1933*e* : 422; Parrot, 1942 : 330, 331. In part.]
Phlebotomus (*Prophlebotomus*) *theodori* Parrot, 1942 : 332. [Replacement name for *minutus* auctorum from Palestine.]
Sergentomyia (*Sergentomyia*) *theodori* (Parrot); Theodor, 1948 : 101; 1958 : 41; Theodor & Mesghali, 1964 : 294.
Sergentomyia (*Sergentomyia*) *dentata* (Sinton) form *theodori*; Lewis, 1974*b* : 191.

This belongs to a complex of closely related species and variants (Lewis, 1974*b*), and its female has a wider pharynx than in typical *S. dentata.*

Sergentomyia (*Sergentomyia*) *theodori pashtunica* Artemiev

(Map 6)

Phlebotomus minutus (Rondani); Sinton, 1932*a* : 61, 73 [in part]; 1933*d* : 421 [in part].
Sergentomyia (*Sergentomyia*) *theodori* (Parrot); Lewis, 1967 : 27.

Sergentomyia (*Sergentomyia*) *theodori pashtunica* Artemiev, 1974*b* : 333. Syntypes 124 ♀, 209 ♂, AFGHANISTAN (depository unknown) [not examined].

In the female, *S. t. pashtunica* has fewer cibarial teeth (22 = 18–24) and a shorter labrum (0·14 = 0·13–0·16 mm) than the nominate form, and in the male differs by having a shorter labrum (0·12–0·14) and shorter antenna 3 (0·10–0·11). Further study of variation and distribution is needed to settle the status of *S. theodori* and its subspecies.

♀ (*extra facts*). Fascicle much as in *S. dentata*, number of maxillary lateral teeth variable.

DISTRIBUTION. **Pakistan:** Dehra Ismail Khan, Kashmore, Landi Kotal, Larkana, Peshawar, Rawalpindi (Lewis, 1967 : 27).

Sinton (1932*a*) stated that '*P. minutus*' (= *S. theodori*) in the Indian subcontinent occurred chiefly in the north-western plains.

Subgenus ***PARROTOMYIA*** Theodor

Sergentomyia africana group Theodor, 1948 : 101.

Sergentomyia subgenus *Parrotomyia* Theodor, 1958 : 42; Perfil'ev, 1968 : 318; Artemiev, 1976*b* : 428 [some abdominal dorsal hairs erect in certain species]. Type-species: *Phlebotomus africanus* Newstead, 1912 : 363 (described as var.), by original designation.

A comb-like cibarial armature, lamp-glass-shaped pharynx, and elliptical capsular spermatheca are characteristic of many species, but it is sometimes necessary to consider all the characters given in couplet 69 of the key, and even they are not easily applicable in every case. The subgenus is large and widely distributed. Some species have a short R_2.

The species are here placed in the *africana*, *denticulata*, *babu* and *grekovi* series. In the *africana* series the ventral plate of the cibarium has no notch and the spermatheca is oblong. A few forms (*brevicaulis*, *himalayensis*, *mangana* and *queenslandi meridionalis*) differ somewhat from the rest in having a very high average, or sometimes maximum, number of cibarial hind teeth which may also be very long with the outer ones directed slightly outward. Members of the *denticulata*-group, which includes the Australasian *S. spinosior* (Quate & Quate), are like those of the *africana*-group but have numerous parallel teeth so narrow (apparently less than a micron wide) as to be invisible at most magnifications. The teeth are about as numerous as some in the *africana*-group which are visible because they occupy a wider space and lean outward near the edges. In the *babu*-group the ventral plate of the cibarium has a hind notch, and the spermatheca is oblong. In the *grekovi*-group the spermatheca is nearly spherical.

***Sergentomyia* (*Parrotomyia*) sp. (A) Kaul, Dhanda & Modi**

(Map 6)

Sergentomyia (*Parrotomyia*) sp. A Kaul, Dhanda & Modi, 1973 : 535 [♂].

This species from the Kota district, India, may be a new one related to *S. grekovi*.

Sergentomyia* (*Parrotomyia*) *africana magna (Sinton) form ***asiatica*** Theodor **stat. n.**

(Map 6)

Phlebotomus africanus Newstead; Adler & Theodor, 1927 : 63 [Jericho]; Sinton, 1932*a* : 61; 1933*e* : 42.

Phlebotomus africanus var. *asiaticus* Theodor, 1933 : 541; 1952 : 116 [relation to Israel form unknown]. Syntypes, ISRAEL (TC) [not examined].

Sergentomyia (*Parrotomyia*) *africana* var. *asiatica* (Theodor); Theodor, 1948 : 110.

Sergentomyia (*Parrotomyia*) *africana asiatica* (Theodor); Theodor, 1958 : 45; Lewis, 1967 : 28; Perfil'ev, 1968 : 331.

Phlebotomus africanus asiaticus Theodor; Abonnenc & Yvore, 1969 : 184; Bailly-Choumara, Abonnenc & Pastre, 1971 : 454; Abonnenc, 1972 : 172.

Phlebotomus (*Sergentomyia*) *africanus asiaticus* Theodor; Abonnenc, 1972 : 172.

The cibarium of the female has 45–50 teeth in a concave row and no central patch of fore teeth, and the pigment patch is concave posteriorly and has a simple forward process, and there is no notch in the ventral plate. The pharynx has long teeth and the spermatheca is oblong.

The *S. africana* complex is mainly African and includes a number of forms which have a comb-like cibarial armature and oblong spermatheca, and have been variously treated as several species or as one by Quate (1964). His citation of 36 name-combinations occupies 137 lines and shows the confusion which existed for many years. He, Lewis (1974*b*) and others have emphasized the degree of intergradation between some named forms. There is so much variation that anyone with a large collection at his disposal could, if so minded, create still more names for local variants. For these reasons I regard *S. a. magna* as no more than a subspecies.

No certain specimens of the Pakistan form are available, but it probably belongs to a small northern form found in Morocco, Israel and India, which Abonnenc & Yvore (1969 : 184, 185) and Abonnenc (1972 : 172) treated as a subspecies of *africanus*. Rioux *et al.* (1975) regarded it as infra-subspecific. For the present I am treating the Pakistan form as a form of *S. a. magna*.

MATERIAL EXAMINED.
India: Palod (1934, *M. O. T. Iyengar*), 1 ♀ with about 38 hind teeth and a very concave pigment patch may be related.

DISTRIBUTION. **Pakistan:** Kandhkot, Rhedia, Shikarpur (Lewis, 1967 : 28).

Sergentomyia (*Parrotomyia*) sp. (B) Kaul, Dhanda & Modi

(Map 6)

Sergentomyia (*Parrotomyia*) sp. B Kaul, Dhanda & Modi, 1973 : 536 [♂].

Males from Kota district, India, may be a new species. It is provisionally put in the *africana*-group.

Sergentomyia (*Parrotomyia*) *babu* (Annandale)

Phlebotomus babu Annandale, 1910*b* : 49.

The cibarium of the female has a deep notch in the ventral wall and 24–50 teeth.

Sinton (1932*a* : 60; 1933*e* : 422) pointed out the close affinity between *S. babu*, *S. baghdadis* and *S. shorttii* but retained their specific status in view of their morphology and distribution. *S. babu* and *S. baghdadis* overlap in a considerable area with little intergradation, but many intermediate females, classed here as a *S. babu* variant, have been found in the Sagar (Shimoga) area. Females from Nander and Parbhani, intermediate between *S. baghdadis* and *S. shorttii*, are classed here as a *S. baghdadis* variant; typical *S. baghdadis* may not occur there. *S. babu* and *S. baghdadis*, and now *S. shorttii*, are known to overlap in large enough areas to be regarded as species, but their true status must await further knowledge.

Sergentomyia (*Parrotomyia*) *babu babu* (Annandale)

(Map 6)

Phlebotomus sp., Howlett *in* Maxwell-Lefroy, 1909 : 559 [?].
Phlebotomus babu Annandale, 1910*b* : 49; Sinton, 1927*e* : 31; 1928*b* : 185; 1928*c* : 314; 1932*a* : 60; 1933*d* : 422; Theodor, 1938 : 264 [24–34 cibarial teeth in ♀]. Lectotype ♂, INDIA (Zoological Survey of India, Calcutta), designated by Quate, 1962*c* : 158 [not examined].
Phlebotomus babu var. *niger* Annandale, 1911*c* : 320; Sinton, 1928*c* : 315; 1932*a* : 60. Type, INDIA (believed by Quate to be lost) [not examined]. [Synonymized by Sinton (1932*a*) and Quate (1962*c*).]
Phlebotomus minutus var. *niger* Annandale; Sinton, 1924*a* : 812; 1927*d* : 25; 1927*e* : 31.
Phlebotomus (*Prophlebotomus*) *babu* Annandale; Parrot, 1940 : 311.
Phlebotomus thapari Mitra & Roy, 1952 : 88. Holotype ♀, INDIA (depository unknown) [not examined]. **Syn. n.**

Phlebotomus (*Sergentomyia*) *babu* var. *niger* Annandale; Quate, 1962*c* : 158.
Phlebotomus (*Sergentomyia*) *babu* Annandale; Quate, 1962*c* : 157.
Sergentomyia (*Parrotomyia*) *babu* (Annandale); Lewis, 1967 : 88; Artemiev, 1976*b* : 422.

The cibarium of the female has 24–34 teeth. In an aberrant female from India in the BMNH, marked K1 by Sinton, vein R_2 is absent in one wing and very short in the other.

The form *thapari*, based on a single female, appears to be a synonym, and some of its features due to artefacts and interpretation.

Distribution. **India:** Abu Mount, Badam Pahor, Delhi, Krishnagar, Nagpur, Osmanabad, Pinjaur, Saharanpur (BMNH); Aurangabad, Jalna, Patan (Farooq & Qutubuddin, 1945 : 85); Ajmer, Sambhar (Jaswant Singh, 1933); Tibi area (*N. L. Kalra*); Jalor, Kota, Sirohi (Kaul *et al.*, 1973 : 532); Calcutta, Poona, Pusa (Lewis, 1967 : 30); Allahabad, Asansol, Igatpuri, Palod Port Canning, Purnea, Rajmahal, Rambha, Trivandrum (Quate, 1962*c* : 158); Bikaner (Sharma *et al.*, 1973*c*); Bombay, Chindwara, Faizabad, Itarsi, Itaunia, Junaghad, Kamptee, Karnal, Kurseong, Mhow, Nabinagar, Panchmarhi, Patna (Orissa), Pipariya, Rajkot, Singanama, Titilagarh (Sinton's notes); Sagar (Shimoga) area (some typical, many with about 22 cibarial teeth), Wai (H. *Trapido*); Naini Tal (Wattal *et al.*, 1967). **Pakistan:** Cherat, Gilgit, Lahore, Kotal, Rawalpindi, Taxla (Lewis, 1967 : 30); Khanki (Sinton's notes).

According to Sinton (1928*c* : 315; 1932*a*), *S. babu* was the main component of '*P. minutus*' till 1928, and was evidently widely distributed over the Indo-Pakistan plains and foothills. Many localities of this common species are omitted from the above list.

Sergentomyia (*Parrotomyia*) *babu insularis* (Theodor)

(Map 6)

Phlebotomus babu var. *insularis* Theodor, 1938 : 264. Syntypes 6 ♀, 7 ♂, Sri Lanka (TC) [not examined].
Sergentomyia (*Sergentomyia*) *babu* var. *insularis* Theodor; Theodor, 1948 : 110.
Phlebotomus babu Annandale or ally [?]; Carter & Antonipulle, 1949 : 68.
Sergentomyia (*Sergentomyia*) *babu insularis* Theodor; Lewis, 1973*a* : 249.

The cibarial teeth of the female number 45–50. There is much variation in the number of teeth in some species of *Parrotomyia*, and this form is treated as a subspecies partly owing to its geographic isolation.

Distribution. **Sri Lanka:** Depanama, Maharamgama, Pannipitiya (Theodor, 1938 : 266).

Sergentomyia (*Parrotomyia*) *baghdadis* (Adler & Theodor)

(Map 7)

Phlebotomus baghdadis Adler & Theodor, 1929 : 281; Sinton, 1932*a* : 60; 1933*e* : 422. ♀♂ syntypes, Iraq (TC) [not examined].
Sergentomyia (*Parrotomyia*) *baghdadis* (Adler & Theodor); Lewis, 1967 : 30; Artemiev, 1976*b* : 424.

The female has about 16–20 cibarial teeth, a notch near them, and a weak pharyngeal armature.

Distribution. **India:** Nander and Parbhani (with 16–18 rather uniform cibarial teeth and a small or very small notch, *V. Dhanda*); Riasi (Jacob & Kalra, 1951 : 325); Ajmer, Sambhar (Jaswant Singh, 1933); Jaipur, Kota (Kaul *et al.*, 1973 : 532); Punch, Rajouri (Mitra, 1959 : 62); Ferozepore, Karnal (Sinton's notes). **Pakistan:** Sukkur (BMNH); Bannu, Dehra Ismail Khan, Gujranwala, Gujrat, Jandola, Jhelum Kandhkot, Kashmore, Lahore, Landi Kotal, Larkana, Lyallpur, Mir Muhammad, Pano Aqil, Peshawar, Rawalpindi, Rohri, Said Pur, Sarghoda, Shikarpur, Tank, Taxla (Lewis, 1967 : 31).

In the Indian subcontinent this species occurs in the west and north-west (Sinton, 1932*a*).

Sergentomyia (*Parrotomyia*) *barraudi* (Sinton)

(Figs 62–69, Map 7)

Phlebotomus barraudi Sinton, 1929*a* : 716; 1932*a* : 61; 1933*e* : 422; Raynal & Gaschen, 1934*b* : 559; 1935*a* : 113; Raynal, 1935*b* : 285; Theodor, 1933 : 542 [variety of *africana* ?]; 1938 : 268 [variation]; Tonnoir, 1935 : 142; Yao & Wu, 1941*b* : 78. Syntypes ♀ ♂, INDIA (depository unknown) [not examined].

Phlebotomus (*Prophlebotomus*) *barraudi* Sinton; Parrot, 1937 : 120; 1940 : 311; 1946 : 70; Parrot & Clastrier, 1952 : 158.

Phlebotomus barraudi var. *siamensis* Causey, 1938 : 488. Syntypes 2 ♀, THAILAND (depository unknown) [not examined]. [Synonymized by Quate, 1962*b* : 261.]

Phlebotomus barraudi var. *kwangsiensis* Yao & Wu, 1941*a* : 67; 1941*b* : 77. Syntypes 2 ♀, 1 ♂, CHINA (depository unknown) [not examined]. [Synonymized by Quate, 1962*b* : 261.]

Phlebotomus barraudi var. *siulamensis* Chen & Hsu, 1955 : 302; Leng, 1964 : 124, 127. Syntypes, CHINA: Samshuihsien (Hua Nan Medical College, Canton) [not examined]. **Syn. n.**

Sergentomyia (*Parrotomyia*) *barraudi* (Sinton); Theodor, 1958 : 44; Lewis & Dyce, 1976 : 208.

Phlebotomus (*Sergentomyia*) *barraudi* Sinton; Quate, 1962*b* : 261; Cates & Lien, 1970 : 535.

The normally bifid shape of the pigment patch of the female is a characteristic feature of this species. The number of cibarial teeth in the female is recorded by Causey, Chen & Hsu, Lewis & Dyce, Quate, Raynal (1935), Sinton (1929) and Theodor, and ranges from about 40 to about 70, being particularly high in some eastern areas. The following note is based on females from West Malaysia.

♀. Tip of labrum small and median apical sensilla prominent. Hypopharyngeal teeth delicate. Mandible pointed. Maxilla with 2·8 (2–4) lateral nodular teeth and 35·4 (35–36) ventrals (n = 5); dental depth 0·10 mm; lateral teeth distinctly smaller in West Malaysia than in India and East Timor.

Professor O. Theodor informed me (1971, in letter) that specimens from Taiwan resemble the type form in general but differ in having a shorter antenna 3 in the female and a short wide pigment patch like that of some Chinese specimens. He remarked that the species seemed to have some local forms and that more material was necessary for assessing their status.

MATERIAL EXAMINED.

Hong Kong: Hong Kong (*G. W. Chau*), 1 ♀ (with 64 hind teeth and faint or no pigment patch, and much indented cibarium and pharynx), 2 ♀ (with about 70 teeth). **Java:** Semarang, ii.1910 (*E. Jacobson*), 1 ♀ (with some 90 cibarial teeth about 6 μm wide, a partly divided process of the pigment patch, and a nodular hind margin of the cibarial ventral plate; it may be related to *S. barraudi*). **West Malaysia:** Gunong Besout area.

DISTRIBUTION. **Bangladesh:** Dhurmakura (Sinton's notes). **Burma:** Mezali (Sinton's notes). **Cambodia:** Phnom Penh (Parrot & Clastrier, 1952 : 153). **China:** Sainan, Suilam (Chen & Hsu, 1955 : 302); Hainan (Leng, 1964 : 127); Se-Tchouen (Gaschen, 1934 : 890; Raynal, 1935*b* : 290); Mang-shih, Nanning, Tienpao (Yao & Wu, 1941*a* : 67; 1941*c* : 79). **Hong Kong:** (as above). **India:** Golaghat (Sinton, 1929*a* : 716); Gauhati (Sinton's notes). **Laos:** Vientiane (Quate, 1962*b* : 261); Xieng Khouang (Raynal, 1935*b* : 290). **Nusa Tenggara:** Dili, Sumbawa (Lewis & Dyce, 1976 : 208). **Japan:** Ryukyu Retto, Iriomote Island (Ohara), 1963 (*G. A. Samuelson*), 1 ♀; R. R., Ishigaki Island (Banna), 1963 and 1964 (*J. L. Gressitt & G. A. Samuelson*, U.S.–Japan Cooperative Scientific Programme), via BPBM, 18 ♀, 1 ♂, the only species found. **Taiwan:** Hengchun (*C. M. Yoshimoto*); Hualien area, Tapei area, Taitung (Cates & Lien, 1970 : 537, *T. C. Maa*); Kuraru (*C. M. Yoshimoto*). **Thailand:** Bangkok (Causey, 1938 : 388); Phra Phuttabat area (Quate, 1962*b* : 261). **Vietnam (North):** Cho Ganh (Raynal, 1935*b* : 290). **Vietnam (South):** Di Linh (Quate, 1962*b* : 261); Duc Pho (Raynal, 1935*b* : 290). **West Malaysia:** Gunong Besout Forest Reserve (*A. B. Knudsen & colleagues*); Klang, Ulu Gombak (*D. J. Lewis*); Kuantan, Tanjong Rabok (*A. Rudnick*).

In Indo-Burma Sinton (1932*a*) knew *S. barraudi* only from Assam and Burma. In Indo-China Raynal (1936*a* : 366) found it between 15° and 25° north, where it was abundant at 1200 and 1600 m in particular, and he regarded it as a hill species.

Sergentomyia (*Parrotomyia*) *bigtii* (Manalang)

(Map 7)

Phlebotomus bigtii Manalang, 1931 : 356; Raynal, 1935*a* : photograph 18; Quate & Rosario, 1962 : 797;

Quate, 1965 : 28. Lectotype ♀, PHILIPPINES (on loan to BPBM), designated by Quate, 1965 : 28 [not examined].

The female of this large species has 10–12 bent pointed teeth, a rather narrow dark pigment patch and a thick mass of pharyngeal teeth.

DISTRIBUTION. **Philippines:** Bigti, Malinao (Quate, 1965 : 28).

Sergentomyia (*Parrotomyia*) *brevicaulis* (Quate)

(Map 7)

Phlebotomus (*Sergentomyia*) *brevicaulis* Quate, 1962*b* : 256. Holotype ♀, VIETNAM (SOUTH) (BPBM) [not examined].

This is a large species with, in the female, about 73 cibarial hind teeth (number taken from figure), about 50 fore teeth in one row, a large pigment patch and long antenna 3 and R_2.

DISTRIBUTION. **Vietnam (South):** Di Linh area (Quate, 1962*b* : 259).

Sergentomyia (*Parrotomyia*) *brevinervis* (Quate & Fairchild)

(Map 7)

Phlebotomus (*Sergentomyia*) *brevinervis* Quate & Fairchild, 1961 : 214 [♂]. Holotype ♂, BORNEO (BPBM) [not examined].

In the male there are 14 cibarial hind teeth and 13 fore teeth, no pigment patch, short antenna 3 and a narrow wing with short R_2. The authors compared the male with *S. babu*. The species is placed provisionally in the *africana*-group.

DISTRIBUTION. **Borneo** (Sabah): Ranau (Quate & Fairchild, 1961 : 214).

Sergentomyia (*Parrotomyia*) *bukidnonis* (Quate)

(Map 7)

Phlebotomus (*Sergentomyia*) *bukidnonis* Quate, 1965 : 33. Holotype ♀, PHILIPPINES (BPBM) [not examined].

In the female of this small species the broad cibarium has 30–34 sharp teeth in a crown-like row and 18–24 fore teeth in one row, the pharynx is unarmed, antenna 3 is short, palpal segment 4 is long, and R_2 is longer than R_{2+3}.

DISTRIBUTION. **Philippines:** Cuernos de Negros, Katanglad Mountain (Quate, 1965 : 33).

Sergentomyia (*Parrotomyia*) *dayapensis* (Manalang)

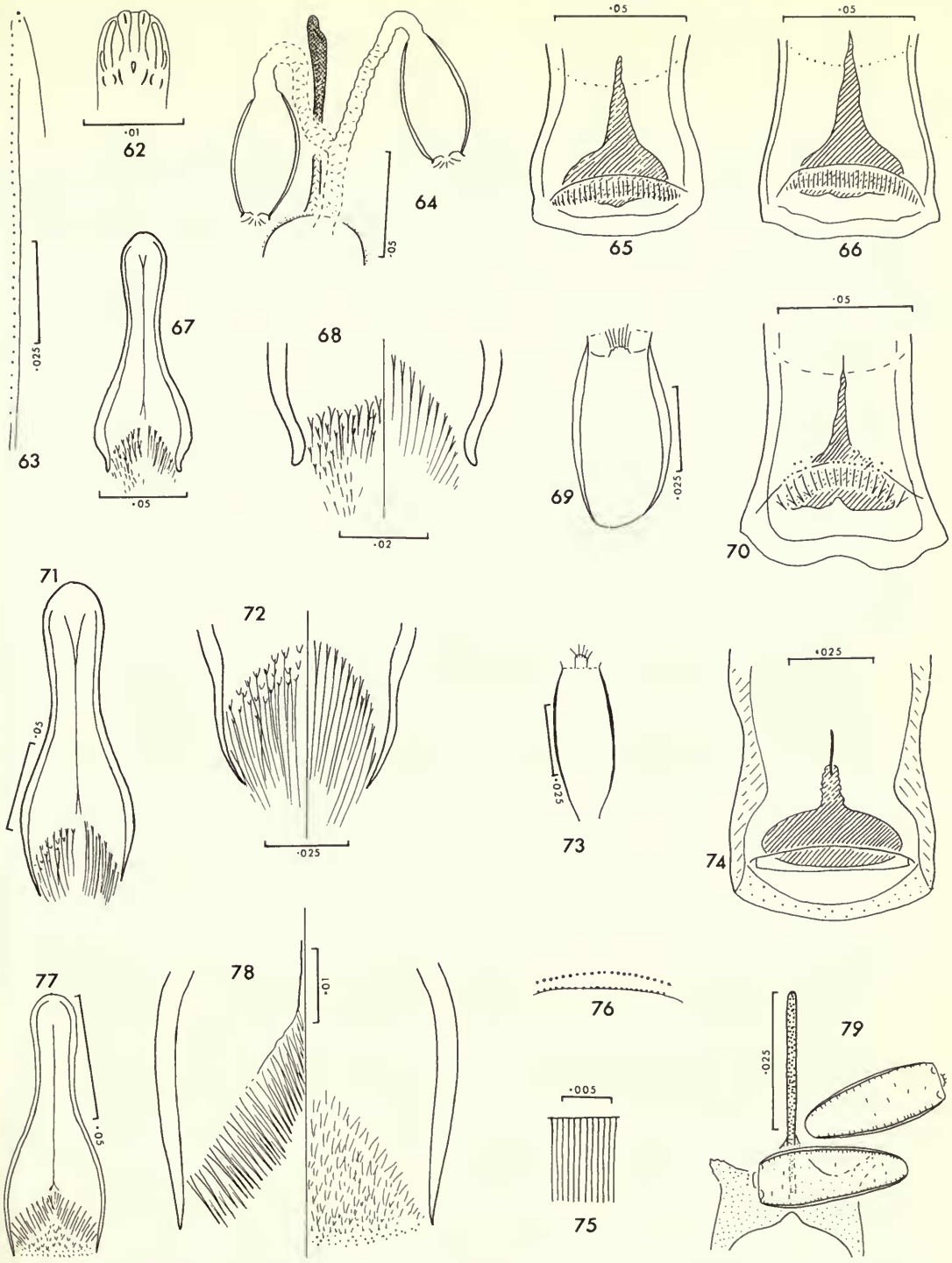
(Map 7)

Phlebotomus dayapensis Manalang, 1931 : 358; Raynal, 1935*a* : photograph 17. Holotype ♀, PHILIPPINES (destroyed, according to Quate & Rosario) [not examined].

Phlebotomus (*Sergentomyia*) *dayapensis* Manalang; Quate & Rosario, 1962 : 793 [specificity of ♂ questioned].

In the female the cibarium has some 24 teeth and a broad pigment patch, the pharynx is unarmed, and R_2 equals R_{2+3}.

DISTRIBUTION. **Philippines:** Dayap (Manalang, 1931 : 355).



Figs 62–79 *Sergentomyia* species. 62–64, *S. barraudi*, ♀ (from Gunong Besout area), labral tip, maxilla and spermatheca. 65–69, *S. kauli*, ♀: (65, 66) cibarium; (67, 68) pharynx; (69) spermatheca. 70–73, *S. modii*, ♀: (70) cibarium; (71, 72) pharynx; (73) spermatheca. 74–79, *S. rudnicki*, ♀: (74–76) cibarium, hind teeth, and fore teeth after KOH treatment; (77, 78) pharynx; (79) spermatheca.

Sergentomyia (*Parrotomyia*) *denticulata* (Quate & Fairchild)

(Map 7)

Phlebotomus (*Sergentomyia*) *denticulatus* Quate & Fairchild, 1961 : 216. Holotype ♀, Borneo (BPBM) [not examined].

The cibarium of the female has about 90 teeth pointing upward, each one being very narrow (apparently less than 1 μm wide) so that at most magnifications the armature looks like a sheet of chitin. The fore teeth number about 20, the pharynx is unarmed, the scutum is brown, and R_2/R_{2+3} is about 1·9. Labrum 0·09 length of wing, in a female paratype.

A female from Sepilok is provisionally placed in this species although its labrum is 1·25 length of wing and the cibarial teeth are scarcely visible, perhaps obscured by food or other structures.

Distribution. **Borneo** (Sabah): Sepilok (*D. J. Lewis*, ?1 ♀); Gomantong Caves, Ranau (Quate & Fairchild, 1961 : 217).

Sergentomyia (*Parrotomyia*) *franciscana* (Quate)

(Map 7)

Phlebotomus (*Sergentomyia*) *franciscanus* Quate, 1965 : 33. Holotype ♀, Philippines (BPBM) [not examined].

In the female the cibarium has 24–26 teeth in a crown-like row and 14–18 fore teeth in one row, the pharynx is unarmed, and R_2 is shorter than R_{2+3}.

Distribution. **Philippines:** San Francisco area (Quate, 1965 : 33).

Sergentomyia (*Parrotomyia*) *grekovi* (Khodukin)

(Map 7)

Phlebotomus grekovi Khodukin, 1929 : 101. Syntypes ♀, ♂, U.S.S.R. (depository unknown) [not examined].

Sergentomyia (*Parrotomyia*) *grekovi* (Khodukin); Theodor, 1958 : 44; Lewis, 1967 : 32; Perfil'ev, 1968 : 319; Artemiev, 1976*b* : 425.

In the female the cibarium has 18–35 teeth, possibly indicating more than one form, and the spermatheca is nearly spherical. Artemiev, in Afghanistan, noted much variation in numbers of teeth, and the presence of some erect hairs on certain abdominal tergites.

Distribution. **Pakistan:** Gilgit (Lewis, 1967 : 34).

Sergentomyia (*Parrotomyia*) *himalayensis* (Annandale)

(Map 7)

Phlebotomus himalayensis Annandale, 1910*b* : 50; Sinton, 1924*a* : 811; 1924*b* : 321; 1931*b* : 828; 1932*a* : 62 [♀]; 1933*e* : 421. Lectotype ♀, India (Zoological Survey of India), designated by Quate, 1962*c* : 158 [not examined].

Phlebotomus (*Sergentomyia*) *himalayensis* Annandale; Quate, 1962*c* : 158.

The female has about 80–100 cibarial hind teeth in a slightly concave line and a triradiate pigment patch, and many short stout pharyngeal teeth. The male has about 40 cibarial teeth and its style bears at or near the tip three large spines, one small spine and the usual seta.

Material examined.

Three females from the Jog-Sagar area of **India** (*H. Trapido*), with 66 hind teeth and a roundly truncated process on the pigment patch, may be this species or a related form.

DISTRIBUTION. **India:** Bhowali, Naini Tal (Brunetti, 1912 : 205; Sinton, 1928*c* : 321); Kurseong (1520 m in eastern Himalayas, Sinton, 1924*b* : 817).

Sergentomyia (*Parrotomyia*) *kauli* Lewis **sp. n.**

(Map 7)

The female slightly resembles *S. africana*, but has a narrow pigment patch, and very short upper pharyngeal teeth and long lower ones.

♀. Labrum 0·23 (0·22–0·25) mm long, 0·11 (0·10–0·12) length of wing. Cibarium with 26–32 teeth, fore teeth if present hidden by pigment patch; patch dark with broad anterior process. Pharynx with long teeth. Antenna 3 = 0·23 (0·22–0·24) mm long, 0·12 (0·11–0·12) length of wing, 1·08 (1·03–1·14) length of 4+5, 1·01 (0·90–1·09) length of labrum, ascoid on 4 about 0·43 length of segment and not reaching next one. Wing length 1·95 (1·84–2·16) mm, 3·5 times width, R_2/R_{2+3} 1·82 (1·66–2·11), R_1 tip/R_2 0·65 (0·58–0·68). Spermatheca thick-walled and oblong with straightening very near tip.

COMMENTS. The specimens from Saharanpur had been provisionally labelled '*P. malabaricus*' and presented to the BMNH by J. A. Sinton. Therefore they were first presumed to be *S. modii* which had been regarded as the female of *S. malabarica* till the true female was found. *S. kauli* is shown to be a separate species, however, by the rounded hind lateral walls of the cibarium, more numerous hind teeth, lack of conspicuous irregular fore teeth, broad forward process of the pigment patch, shorter antenna 3 and ascoid, and relatively short R_2.

MATERIAL EXAMINED.

Holotype ♀, **India:** Ganjam, 21.xi.1972 (*H. N. Kaul*) (BMNH).

Paratypes. **India:** Ramanagar, 28.viii.1970 (*H. R. Bhat*), 400 m, 1 ♀; Saharanpur, ix-x.1927 (*J. A. Sinton*), 4 ♀. (All in BMNH.)

Non-paratypic material. **India:** Munikireti, 6.iii.1973 (*H. R. Bhat*), 1 ♀ (BMNH).

Sergentomyia (*Parrotomyia*) *mangana* (Manalang)

(Map 7)

Phlebotomus mangana Manalang, 1930*c* : 283; Tonnoir, 1935 : 142. Lectotype ♀, PHILIPPINES (BPBM), designated by Quate & Rosario [not examined].

Phlebotomus (*Sergentomyia*) *mangana* Manalang; Quate & Rosario, 1962 : 793.

The cibarium of the female has 65–70 hind teeth, two rows of 20–25 fore teeth, and between them six to eight larger teeth; palpal segment 1 is long.

DISTRIBUTION. **Philippines:** Tunkong Manga (Manalang, 1930*c* : 283); Bigti, La Mesa dam area, Los Baños, San José del Monte, San Mateo, Silang, Tala (Quate & Rosario, 1962 : 794).

Sergentomyia (*Parrotomyia*) *modii* Lewis **sp. n.**

(Figs 70–73, Map 7)

Phlebotomus sp. Sinton, 1927*a* : 933 [measurements].

[*Phlebotomus malabaricus* Annandale; Sinton, 1927*d* : 25 [spermatheca]; 1928*c* : 321; 1932*a* : 61, 74 [cibarium and pharynx]. Misidentification.]

S. modii is distinguished from *S. kauli* by having fewer hind teeth, and from *S. yoshimotoi* by having a pigment patch. Aspects of *S. modii* are noted under *S. malabarica*

♀. Labrum 0·25 (0·24–0·26) mm long, 0·12 (0·11–0·12) length of wing. Cibarium with 17 hind teeth and a few irregular fore teeth; pigment patch with long, rather narrow, forward extension. Pharynx with long teeth. Hypopharynx smooth. Antenna 3 = 0·31 (0·30–0·32) mm long, 0·14 (0·14–0·15) length of 4+5, 1·25 (1·22–1·27) length of labrum; ascoid on 4 = 0·74–0·82 length of segment and extending to 5. Palpal ratio 10 : 22 : 32 : 35 : 72. Wing length 2·16 (2·16–2·16) mm, 3·3 times width, R_2/R_{2+3} 2·97 (2·48–3·45), R_1 apex/R_2 0·79 (0·75–0·82). Spermatheca oblong with well-defined smooth wall.

MATERIAL EXAMINED.
Holotype ♀, **India:** Gologhat, v.1925 (*P. J. Barraud*) (BMNH).
Paratype. 1 ♀, same data as holotype but 22.v.1925 (BMNH).
Non-paratypic material. A female with 28 hind teeth from Banhasa, India, may be related to this species.

Sergentomyia (*Parrotomyia*) *palestinensis* (Adler & Theodor)

(Map 8)

Phlebotomus palestinensis Adler & Theodor, 1927 : 64. Holotype ♀, ISRAEL (TC) [not examined].
Sergentomyia (*Parrotomyia*) *palestinensis* (Adler & Theodor); Theodor, 1958 : 44; Lewis, 1967 : 34; Perfil'ev, 1968 : 326; Artemiev, 1976*b* : 427.

The female has 15–22 cibarial teeth in a straight line and a nearly spherical spermatheca. Artemiev noted the close relationship of this species to *S. sogdiana* (Parrot).

DISTRIBUTION. **Pakistan:** Peshawar (Lewis, 1967 : 34).

Sergentomyia (*Parrotomyia*) *queenslandi* (Hill)

Phlebotomus queenslandi Hill, 1923 : 83. Syntypes 4 ♀, 4 ♂, AUSTRALIA (National Museum, Melbourne) [not examined].

The pharynx of the female has hair-like scales and about 45–80 cibarial teeth.

Sergentomyia (*Parrotomyia*) *queenslandi meridionalis* (Tonnoir)

(Map 8)

Phlebotomus queenslandi meridionalis Tonnoir, 1935 : 140. Syntypes 8 ♀, ♂, AUSTRALIA (Division of Economic Entomology, Melbourne) [not examined].
Sergentomyia (*Sergentomyia*) *queenslandi* var. *meridionalis* (Tonnoir); Theodor, 1948 : 111.
Sergentomyia (*Parrotomyia*) *queenslandi meridionalis* (Tonnoir); Lewis & Dyce, 1976 : 210.

The female has about 80 cibarial hind teeth. This form is treated as a subspecies till more is known of its variation and distribution.

DISTRIBUTION. **Nusa Tenggara:** Tafara Cape (East Timor, Lewis & Dyce, 1976 : 210).

Sergentomyia (*Parrotomyia*) *rudnicki* Lewis **sp. n.**

(Figs 74–89, Map 8)

In the female of this pale species the cibarial teeth are so narrow as to be scarcely visible, the pigment patch is broad and dark, and the pharyngeal teeth are strong.

The female differs from *S. mangana* in having a short labrum, a shorter row of cibarial teeth (0·056 mm in *mangana*), narrower teeth (0·8 μm in *mangana*), two rows of fore teeth, and simple outline to the forward process of the pigment patch.

The female of *S. rudnicki* differs from *S. queenslandi meridionalis* in having a shorter tooth-row (0·072 mm in *S. q. meridionalis*) and narrower teeth.

The female of *S. rudnicki* differs from the Australasian (West Irian) *S. spinosior* (Quate & Quate) in having a wider cibarial armature, shorter pharyngeal ventral teeth, and a long antenna 3 which is distinctly longer than 4+5.

♀. Labrum 0·16 (0·15–0·18) mm long, 0·10 (0·09–0·10) length of wing. Cibarium with a row, about 0·43 mm long, of some 90 scarcely visible teeth, each about 0·05 μm wide; two even rows of about 22 fore teeth (seen in macerated specimens) hidden by dark brown posteriorly convex pigment patch; forward process of patch with irregular margin and merging into suture. Pharynx with thick walls, and straight

sides beyond main bulge, and long narrow teeth, the dorsal ones appearing less long because they are seen foreshortened or end-on. Hypopharynx with no teeth or undulations. Antenna 3 = 0·29 (0·26–0·33) mm long, 0·17 (0·16–0·19) length of wing, 0·12 (0·12–0·13) length of 4+5, 1·80 (1·66–1·92) length of labrum, two ascoids on segments 3–15, that on 4 = 0·395 length of segment, no papilla on 5. Maxilla with nine lateral teeth, 19 ventrals and a dental depth of 0·06 mm; palpal ratio 10 : 21 : 38 : 40 : 80; clavate sensilla not very numerous, on basal half of 3. Scutum, pleuron and whole body pale. Wing length 1·69 (1·63–1·74) mm, 3·3 times width, R_2/R_{2+3} 1·61 (1·41–2·00), R_1 overlap/R_2 0·59 (0·47–0·71). Abdominal tergites 4–6 with about one, two and four erect hairs respectively. Spermatheca oblong and sometimes slightly wrinkled, with broad knob and shallow pit, and very thin ducts.

♂. Labrum 0·15 (0·14–0·16) mm long, 0·10 (0·09–0·10) length of wing. Cibarium with about 26 hind teeth and a rather dark, or pale, subtriangular pigment patch having a thin forward process. Pharynx rather as in ♀ but less armed. Antenna 3 = 0·32 (0·29–0·38) mm long, 0·21 (0·20–0·24) length of wing, 1·16 (1·07–1·29) length of 4+5, 2·18 (2·04–2·40) length of labrum, one ascoid on 3–15. Wing length 1·52 (1·45–1·60) mm, 3·7 times width, R_2/R_{2+3} 1·25 (0·89–1·50), R_1 overlap/R_2 0·57 (0·46–0·67). Aedeagus narrow and tapering to a blunt tip. Filament about 3·5 length of pump. Paramere beaked. Style with two spines terminal and two subterminal, and a seta proximal to them.

MATERIAL EXAMINED.

Holotype ♀, **West Malaysia:** Ulu Gombak, 30.x.1968 (*Abu Hassan bin Omar*) (BMNH). Ten of each sex measured.

Paratypes. **West Malaysia:** as for holotype, 26.viii-30.ix.1968, 14 ♀, 3 ♂; 29.ii.1972 (*D. J. Lewis*), 1 ♀, 8 ♂; Ulu Langat Forest Reserve, 25.vii.1968 (*A. Rudnick*), 1 ♀, 1 ♂. (All in BMNH.)

Sergentomyia (*Parrotomyia*) *shorttii* (Adler & Theodor)

(Map 8)

Phlebotomus shorttii Adler & Theodor, 1927 : 65 [palp formula variable]; Sinton, 1928*c* : 317; 1932*a* : 60; 1933*e* : 422. Syntypes 8 ♀, 8 ♂, INDIA (TC) [not examined].
Phlebotomus (*Prophlebotomus*) *shorttii* Adler & Theodor; Parrot, 1937 : 120.
Sergentomyia (*Parrotomyia*) *shorttii* (Adler & Theodor); Lewis, 1967 : 31; Perfil'ev, 1968 : 13.

The female is distinguished by having a notch near the cibarial teeth which number 10–14.

DISTRIBUTION. **Bangladesh:** Dacca (BMNH); Bongong, Kaoraid, Sylhet (Sinton's notes). **Burma:** Rangoon (Sinton, 1927*e* : 31). **India:** Golaghat (Adler & Theodor, 1927 : 66); Gauhati, Sukna (BMNH); Kota (Kaul *et al.*, 1972 : 533); Soraipani (1938, *R. C. Muirhead-Thomson*); Hyderabad (Qutubuddin, 1944 : 208); Naini Tal area (Rao *et al.*, 1973); Calcutta, Jog-Sagar area, Kannur, Konehosur, Kumsi (*H. Trapido*). **Pakistan:** Taxla (Lewis, 1967); Lahore (George, 1970).

Sinton (1928*c*) found that *S. shorttii* represented the *S. babu* complex in Assam, and (1932*a*) knew the former from the north-eastern parts of India and from Burma.

Sergentomyia (*Parrotomyia*) *spinifaucis* (Quate)

(Map 8)

Phlebotomus (*Sergentomyia*) *spinifaucis* Quate, 1965 : 28. Holotype ♀, PHILIPPINES (BPBM) [not examined].

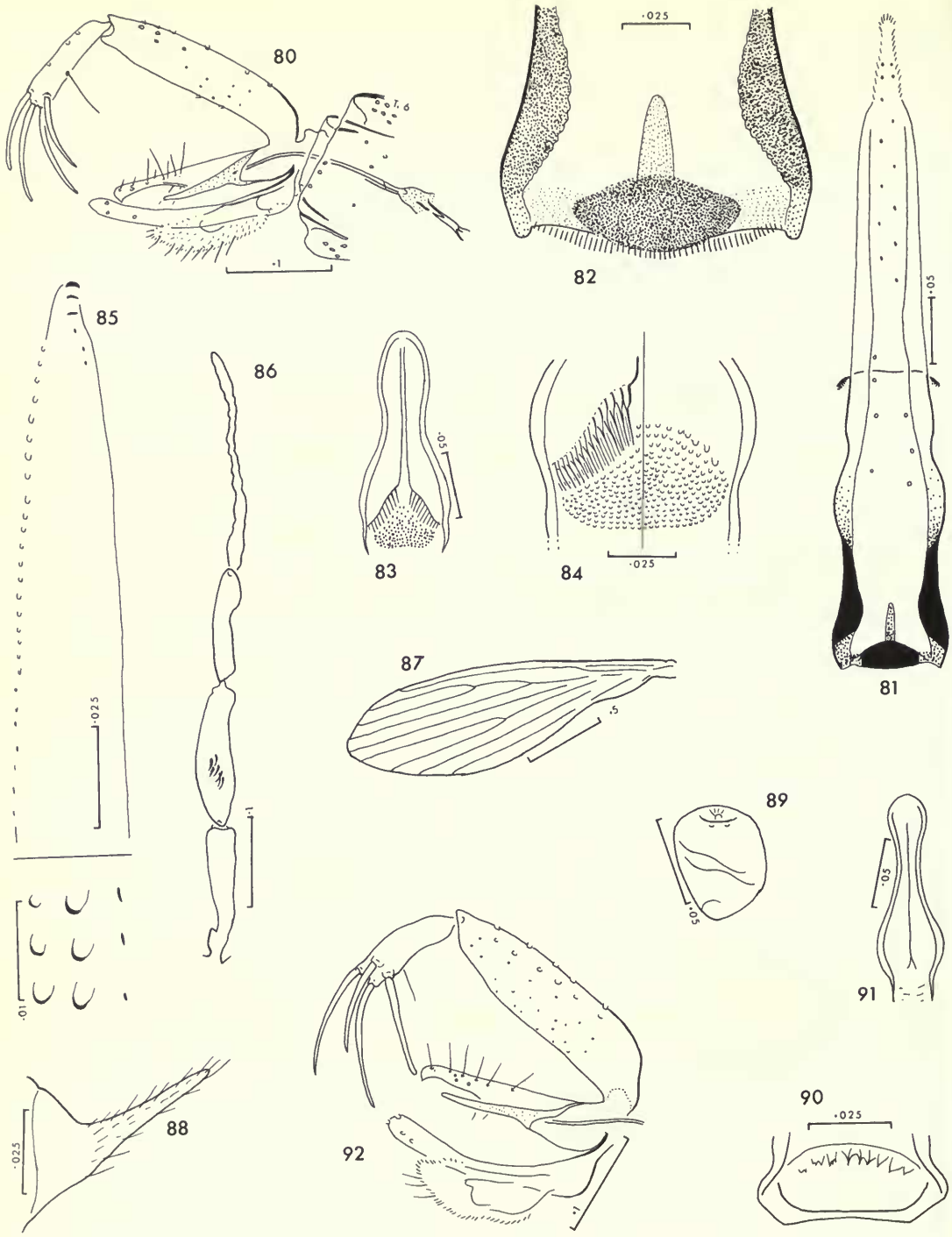
In the female the cibarium has 50–60 teeth in a row concave medially and straight or convex laterally, and 10–12 fore teeth of which the median six are very large; antenna 3 is short and R_2/R_{2+3} is about two. *S. mangana* is somewhat similar but is larger, has a differently shaped tooth-row and a longer antenna 3.

DISTRIBUTION. **Philippines:** Tarumpitao (Quate, 1965 : 28).

Sergentomyia (*Parrotomyia*) *timorica* Lewis & Dyce

(Map 8)

Sergentomyia (*Parrotomyia*) *timorica* Lewis & Dyce, 1976 : 210. Holotype ♀, TIMOR (Australian National Insect Collection) [examined].



Figs 80–92 *Sergentomyia* species. 80, *S. rudnicki*, ♂, terminalia. 81–89, *S. torrechantei*, ♀: (81) labrocibarium; (82) cibarium; (83, 84) pharynx; (85, 86) maxilla and palp; (87) wing; (88) inter-precoxal lobe; (89) spermatheca. 90–92, *S. balica* (from Carey Island): (90, 91) ♀, cibarium and pharynx; (92) ♂, terminalia.

In the female the cibarium has about 60 (50–65) teeth and a slender pharynx with few spicules, and R_2/R_{2+3} is 0.70 (0·24–0·92).

DISTRIBUTION. **Nusa Tenggara:** Dili, Kupang area, Pedang Bay (?), Tafara Cape (Lewis & Dyce, 1976 : 210).

Sergentomyia (*Parrotomyia*) *torrechantei* (Manalang)

(Map 8)

Phlebotomus torrechantei Manalang, 1931 : 361. Syntypes 2 ♀, 1 ♂, PHILIPPINES (destroyed) [not examined].
Phlebotomus (*Sergentomyia*) *torrechantei* Manalang; Quate & Rosario, 1962 : 797.

The original small figures of the female show about 30 cibarial hind teeth, dark walls, a marked pigment patch and long pharyngeal teeth. Quate & Rosario comment that this species appears close to *S. mangana* which has numerous fine cibarial teeth, an armed pharynx and similar wing venation, but that *S. torrechantei* has a shorter palpal segment 4 and a differently shaped pigment patch. The following description is from females believed to be this species.

♀. Eye 0·58 length of head. Labrum 0·17 (0·17–0·18) mm long, 0·09 (0·09–0·09) length of wing, with well-marked sensilla of which the distal ones are broad. Cibarium with about 48 teeth in a slightly convex row, dark, rather narrow, pigment patch with strong forward process, a brown band on ventral wall partly hiding patch, dark sides and a scarcely visible chitinous arch. Pharynx with strong armature of pointed teeth, those on ventral plates conspicuous. Hypopharynx smooth. Antenna 3 (one specimen) 0·35 mm long, 0·18 length of wing, 1·29 length of 4 + 5, 2·10 length of labrum; two ascoids on segments 3–8 (rest missing), that on 4 = 0·55 of its length; no papilla on 5, but several on 6 and 8 near middle. Maxilla with six lateral teeth, three of them very small, and 27 ventral teeth, the proximal ones very small; dental depth 0·09 mm; palpal ratio 10 : 28 : 40 : 34 : 62. Scutum brown and pleura pale. Inter-precoxal lobes narrow. Wing length 1·96 (1·89–2·03) mm, about 3·1 times width, R_2/R_{2+3} 2·36 (1·96–2·88), R_1 overlap/R_2 0·73 (0·67–0·79). Leg ratios: fore (0·69), 10 : 11·2 : – : mid (0·69), 10 : 13·9 : 0·75; hind (0·77), 10 : 15·5 : –. Spermatheca thin-walled and oblong.

DISCUSSION. The specimens described here differ from *S. dapsilidentes* in the shape of the pigment patch, weak chitinous arch and shorter palp 4, and from *S. mangana* in the longer antenna 3. They differ from the description of *S. torrechantei* in having more cibarial teeth and a different pigment patch, and palpal segment 3 = 1·44 times as long as 2 (instead of 1·13 times). However, the dark cibarial walls tally, and palpal segments are somewhat flexible. It seems advisable to regard these specimens as *S. torrechantei*, at least till more examples of this species are found, rather than to create a new species on slender evidence.

MATERIAL EXAMINED.
Philippines: Luzon, Nueva Viscaya, 10.iv.1968 (*M. D. Delfinado & D. E. Hardy*), 4 ♀.

DISTRIBUTION. **Philippines:** Apali, Malinao, Sipocot (Quate, 1965 : 28; Quate & Rosario, 1962 : 797); Nueva Viscaya (as above).

Sergentomyia (*Parrotomyia*) *yoshimotoi* (Quate)

(Map 8)

Phlebotomus (*Sergentomyia*) *yoshimotoi* Quate, 1965 : 24. Holotype ♀, PHILIPPINES (BPBM) [not examined].

In this small species with a brown scutum the female has 14–18 short cibarial teeth in a convex row, no pigment patch and pharyngeal teeth.

DISTRIBUTION. **Philippines:** San Francisco area (Quate, 1965 : 26).

Sergentomyia squamipleuris group Theodor, 1948 : 102.

Sergentomyia subgenus *Grassomyia* Theodor, 1958 : 47; Perfil'ev, 1968 : 339. Type-species: *Phlebotomus squamipleuris* Newstead, 1912, by original designation.

The spermatheca and the expanded tips of the genital filaments, alone, distinguish this small subgenus from others. Its distinctive nature led Abonnenc (1972) to equate it with *Phlebotomus* and *Sergentomyia*. *Grassomyia* is very widely distributed in the Region.

Sergentomyia (*Grassomyia*) *indica* (Theodor)

(Map 8)

Phlebotomus squamipleuris Newstead; Sinton, 1923*b* : 65; 1924*a* : 813; 1927*c* : 947; 1927*d* : 27; 1927*e* : 31; 1928*c* : 321; 1932*a* : 60; 1933*e* : 418, 422; Perfil'ev, 1939 : 82 [in part]; Mitra & Roy, 1955*a* : 324 [abdominal hairs].

Phlebotomus squamipleuris var. *indicus* Theodor, 1931 : 470; 1938 : 269; Lewis, 1957 : 168. Type, 'INDIA' (TC) [not examined].

Phlebotomus (*Prophlebotomus*) *squamipleuris* var. *indicus* Theodor; Parrot, 1937 : 119; Parrot & Clastrier, 1952 : 164.

Phlebotomus squamipleuris var. *poonaensis* Mitra & Mitra, 1953 : 434 [hairs]; Mitra & Roy, 1954 : 191 [description]. Syntypes ♀, INDIA (Museum of the Armed Forces Medical College, Poona) [not examined]. [Synonymized by Abonnenc, 1967 : 115; 1969 : 308.]

Phlebotomus (*Sergentomyia*) *squamipleuris indicus* Theodor; Quate, 1962*b* : 259 [variation].

Phlebotomus (*Grassomyia*) *squamipleuris indicus* Theodor; Abonnenc, 1967 : 114.

Sergentomyia (*Grassomyia*) *squamipleuris indica* (Theodor); Lewis, 1967 : 34.

Sergentomyia (*Grassomyia*) *indica* (Theodor); Theodor & Mesghali, 1964 : 296 [India & China]; Perfil'ev, 1968 : 344; Lewis & Dyce, 1976: 210 [Bali form].

The combination of a convex cibarial tooth-row and rounded spermatheca, in the female, and filaments with dilated tips, in the male, distinguishes this from all other Oriental species.

Various forms of *Grassomyia* in different parts of the Old World have undergone nomenclatorial changes, some of which are as follows. *S. squamipleuris* (Newstead) was described from the Sudan in 1912, *S. ghesquierei* (Parrot) from Zaire in 1929, *S. s. indica* in 1931, *S. dreyfussi* (Parrot) from Algeria in 1933, *S. inermis* (Theodor) from Africa in 1938, and several eventual synonyms at various times. Perfil'ev (1939) placed all members of the complex in one species, without individual names. Quate (1962*b* : 260) treated *indica* as a synonym of *squamipleuris* and (1964) regarded *dreyfussi*, *inermis* and *ghesquierei* also as synonyms. Theodor & Mesghali (1964) recognized four species, *S. dreyfussi*, *indica*, *inermis* and *squamipleuris*, and described *S. d. turkestanica* from Turkestan and eastern Iran. Perfil'ev (1966) recognized five species and described *S. s. karakalensis* from Soviet Central Asia, and (1968, in letter) informed me that this was a synonym of *turkestanica* which might be treated as a subspecies of *squamipleuris*. *S. madagascarensis* (Abonnenc) was described in 1969. O. Theodor (1971, in letter) informed me that *squamipleuris* from Taiwan differed distinctly from *indica*, the pharynx being narrower, pigment patch of different form and cibarial teeth only about 25 in number, and he considered it as good a species as the African ones recognized by Abonnenc in 1969. Lewis (1974*b*) regarded the Yemen form as *S. dreyfussi*, and Lewis & Dyce (1976) studied the Bali form of *S. indica* which differed from West Malaysian and Indian specimens.

According to Theodor and Mesghali, the females of *indica* and *turkestanica*, its nearest geographical relative, have respectively: antenna 3/labrum 0·9 and 1·1–1·2; cibarial teeth, 33–36 and 40; antenna 3 length, 0·12–0·17 and 0·2–0·22 mm; spines on femur 1, none and three to four.

Ten females from Peshawar were examined and had antenna 3/labrum of 0·93 (0·91–0·97). Cibarial teeth were difficult to count in uncrushed specimens, but one chosen at random and so treated showed 46 teeth. Antenna 3 was 0·14 (0·14–0·15). Femoral spines are often lost and their sockets look like those of large hairs. None was seen on many flies examined.

The divergence of views, variation in the complex and appearance of new forms from time to time make it difficult to classify some. For the present I am treating the Oriental form as a species,

S. indica, in which the number of teeth may be unimportant but other characters may later indicate the need for subdivision. The mesanepimeron is bare, as in two African forms.

Distribution. **Cambodia:** Phnom Penh (Parrot & Clastrier, 1952 : 153). **China:** Hainan (Leng, 1964 : 127); Aihsien, Lingshui, Paoting (Yao & Wu, 1940 : 797; 1941*b* : 77). **Hong Kong:** Saikung (*W. J. Voss & Hui Wai Ming*, via BPBM). **India:** Bhavnagar, Guntur, Itauriga, Tittagash, Undi, Vellore (BMNH); Pusa (about as common as *P. argentipes* according to Craighead & Das, 1928 : 863), Ranaghat (*S. Das*); Bir, Parbhani (*V. Dhanda*); Riasi (Jacob & Kalra, 1951 : 325); Kota (Kaul *et al.*, 1951 : 325); Karnal, Saharanpur (Lewis, 1967 : 35); Mendhar, Punch (Mitra, 1959 : 62); Jammu, Nedumangad, Poona, Singanama, Uri (Mitra & Roy, 1953*a* : 324); Kasauli, Madras, Pipariya (Sinton, 1923*b* : 66); Calcutta, Golaghat, Patna (Sinton, 1927*b* : 942); Bombay, Faizabad, Itaunia, Laharpur, Nabinagar, Narnaul, Roorkee, Trivandrum (Sinton's notes); Naini Tal area (Wattal *et al.*, 1967). **Laos:** Luang Prbang, Ventiane (Quate, 1962*b* : 259). **Nepal:** Pokhara (*L. W. Quate* via BPBM), 21 ♀, 4 ♂. **Nusa Tenggara:** Dili, Kabaru, Los Palos, Same, Suai, Sumbara, Tafara Cape, Waingapu Bay (Lewis & Dyce, 1976 : 210). **Pakistan:** Dehra Ismail Khan, Gujrat, Jhelum, Khanki, Lahore, Peshawar, Rawalpindi, Said Pur, Saidu Sharif, Taxla (Lewis, 1967 : 37); Cherat, Shikarpur, Tank (Sinton's notes). **Taiwan:** Henghun area, Pingtung area, Taitung (lowlands south of 32° north, Cates & Lien, 1970 : 535). **Thailand:** Ayutthaya, Bangkok, Chieng Mai, Meung district, Phra Phutthabat district, Tha Li district (Quate, 1962*b* : 259); in trains (Sinton, 1931*d* : 104). **West Malaysia:** Rantau Panjang (Lewis, 1957 : 168); Carey Island (*A. Rudnick*).

In India *S. indica* is widely distributed all over the plains and up to 1830 m (Sinton, 1932*a*).

Subgenus *NEOPHLEBOTOMUS* França & Parrot

Phlebotomus subgenus *Neophlebotomus* França & Parrot, 1920 : 699. Type-species: *Phlebotomus malabaricus* Annandale, 1910, by original designation.

Sergentomyia zeylanica group Theodor, 1948 : 101.

Sergentomyia subgenus *Rondanomyia* Theodor, 1958 : 48; Perfil'ev, 1968 : 335. Type-species: *Phlebotomus malabaricus* Annandale, 1910, by original designation. **Syn. n.**

S. malabarica is now seen to belong in '*Rondanomyia*', but is the type-species of *Neophlebotomus* (discussed by Theodor, 1948 : 88, 89; Kirk & Lewis, 1951 : 406) which was regarded as a synonym of genus *Sergentomyia*. The original characterization of *Neophlebotomus* was indefinite and tentative, and was based on a non-existent character, but it is technically valid nevertheless (ICZN, 1964 : Articles 17(8) and 18(a)). It is therefore treated here as a subgenus, with *Rondanomyia* as a synonym.

A long antenna 3, a broad wing with long R_2 and a style with two spines near the middle class some species as members of this subgenus, but all the features mentioned in couplet 110 of the key must often be considered, and certain species are difficult to classify subgenerically. The figure for R_2/R_{2+3} in six Palaearctic species studied by Theodor (1958) is 1·30 (0·5–1·98), but if the exceptional *S. pawlowskyi* Perfil'ev is omitted the figure is 1·7 (0·75–1·98).

Species of the subgenus occur mainly in areas of high rainfall in the east of the Region where they are comparable with central African members of the subgenus.

Some species of *Sergentomyia* were placed by Theodor (1948) in the *zeylanica* group which was divided into two series according to the nature of the style. Theodor (1958) converted the group to the subgenus *Rondanomyia* but did not mention the two series.

The spermatheca is of some use as a subgeneric character but, as in some other groups, is often difficult to see and define. Although Theodor refers to the tubular spermatheca, it may sometimes be elliptical (Theodor, 1938 : 264).

The species can be grouped (Table 1) according to cibarial armature of the females and what is known of the spermatheca, sometimes from imperfect specimens.

In the *dhandai* series the spermatheca is long and cylindrical.

In the *arboris* series the spermatheca is more or less oblong, with the knob in a pit, and the female has three or more rows of cibarial fore teeth. *S. arboris* is closely related to *S. gombaki*, and *S. malayae* to *S. zeylanica*, and further knowledge of their distribution and variation is needed, with special reference to the length of the labrum.

In the *balica* series the spermatheca is like that of the *arboris* series and the cibarium of the female has less than three rows of fore teeth. *S. jefferyi* differs from most sandflies in its light maxillary armature.

In the *quatei* series the spermathecal knob protrudes proximally and there is no collar. *S. traubi* has a comparable but short spermatheca.

In *S. hamidi* the spermathecal duct starts as a funnel.

This arrangement, which is based on females partly for their biological interest, cuts across Theodor's (1948) sections a and b (based on the central or distal position of two of the spines on the style of the male).

Sergentomyia (*Neophlebotomus*) *arboris* (Sinton)

(Map 8)

Phlebotomus arboris Sinton, 1931*e* : 107; Theodor, 1938 : 263 [♀, previously mistaken for *S. zeylanica*]; Parrot, 1940 : 311; 1946 : 71. About 20 syntype ♂, INDIA (depository unknown) [not examined].
Sergentomyia arboris (Sinton); Theodor, 1948 : 111.
Sergentomyia (*Rondanomyia*) *arboris* (Sinton); Lewis, 1973*a* : 250.

The presence of about eight rows of cibarial fore teeth and the lack of a definite forward process of the pigment patch differentiate the female from all other species.

♀ (*extra facts*). Labrum 0·32 mm long, 0·14 length of wing (2·26 mm). Hypopharynx with smooth tip and low undulations. Antenna 3 = 0·39 mm long, 0·17 length of wing. Maxilla with eight lateral and 58 ventral teeth, dental depth 0·14 mm.

MATERIAL EXAMINED.
India: Baragi, 24.xii.1957 (*H. Trapido*), 1 ♀.

DISTRIBUTION. **India:** Marianbari (Sinton, 1931*e* : 107); Darjeeling, (Theodor, 1938 : 263); Baragi, Hisur, Kannur (*H. Trapido*). **Sri Lanka:** Depanama, Katuwala (Theodor, 1938 : 264).

Sergentomyia (*Neophlebotomus*) *balica* Lewis & Dyce

(Figs 90–92, Map 8)

Sergentomyia (*Rondanomyia*) *balica* Lewis & Dyce, 1976 : 212. Holotype ♀, SUMBAWA (Australian National Insect Collection) [examined].

The female has 18–22 cibarial teeth in a straight line and no pigment patch. *S. bukidnonis*, *S. coronata* (Quate & Quate), *S. crypta* (Quate & Quate), *S. curtata* (Quate) and *S. sansaporensis* Fairchild have a rather similar cibarium but a relatively shorter antenna 3. The male is described below for the first time.

The following measurements of five females from Java (Djakarta, xi.1908; Semarang, i.1910, two; ii.1910, two) agree well with Bali specimens. Labrum 0·20 (0·19–0·20) mm long, 0·10 (0·10–0·10) length of wing. Cibarium with 16–20 hind teeth, accessory fore teeth usually present. Antenna 3 = 0·33 (0·31–0·34) mm long, 0·17 (0·16–0·18) length of wing, 1·36 (1·32–1·44) length of 4+5, 1·67 (1·59–1·74) length of labrum. Palpal ratio about 10 : 23 : 38 : 48 : 67. Wing length 1·97 (1·94–1·98) mm, 3·4 times width, R_2/R_{2+3} 0·83 (0·69–0·93). R_1 overlap/R_2 0·53 (0·49–0·57). Spermathecal ducts not clearly visible.

One incomplete female from Djakarta, xi.1908, apparently of a form near *balica*, has eight cibarial hind tooth and no fore teeth. The labrum is 0·17 mm long and 0·10 length of wing. Antenna 3 is 0·35 mm long, 0·21 length of wing and 2·12 length of labrum. The wing length is 1·68 mm, about 3·5 times width, R_2/R_{2+3} 0·77, and R_1 overlap/R_2 0·47.

♂. Labrum 0·17 (0·17–0·18) mm long, 0·10 (0·10–0·11) length of wing. Cibarium with about eight teeth, some with several points, two or three specks representing fore teeth, and no pigment patch. Pharynx almost unarmed. Antenna 3 = 0·35 (0·35–0·37) mm long, 0·21 (0·20–0·21) length of wing, 1·34 (1·31–1·39) length of 4+5, 2·01 (1·89–2·10) length of labrum, one ascoid on segments 3–14 (15 lacking), that on 4 being about 0·28 length of segment. Wing length 1·70 (1·66–1·74) mm, 3·5 times

width, R_2/R_{2+3} 0·70 (0·66–0·74), R_1 overlap/R_2 0·35 (0·32–0·37). Aedeagus tapering and bluntly pointed. Paramere beaked. Coxite with about 25 scattered brush hairs, mainly in distal half. Style with seta at 0·54, two spines subterminal and two terminal.

Distribution. **Borneo:** Sabah, Tawau (*L. W. Quate*, a female with 24 hind teeth and two rows, of four and eight, fore teeth, which may be this species). **Java:** Djakarta, Semarang (*E. Jacobson*). **Nusa Tenggara:** Denpasar area, Pedang Bay, Sumbawa (Lewis & Dyce, 1976 : 212). **West Malaysia:** Kuala Lumpur (5.vii.1923, *H. M. Pendlebury*, 1 ♀); Carey Island (attracted to man or to CO_2-light-trap, 2 ♀, 3 ♂), Port Dixon (1 ♀) (*A. Rudnick*).

Sergentomyia (*Neophlebotomus*) sp. (Besout)

(Figs 93–94, Map 8)

This species differs from many by having some 95 hairs in the coxite brush. It is left without a formal name till females can be associated with the males.

♂. Labrum 0·20 (0·20–0·21) mm long, 0·13 (0·12–0·13) length of wing. Cibarial hind teeth in the form of minute spicules, roughly arranged in about 12 groups on a concave arc; fore teeth comprising a row of about 12. Pharynx unarmed. Antenna 3 = 0·33 (0·30–0·36) mm long, 0·21 (0·20–0·21) length of wing, 1.37 (1·27–1·34) length of 4+5, 1·63 (1·54–1·72) length of labrum; one ascoid on segments 3–15, that on 4 = 0·55 length of segment. Maxilla with about 20 vestigial ventral teeth. Palpal segment 4 = about 1·3 times length of 3. Scutum pale brown and pleura very pale. Wing length 1·60 (1·51–1·70) mm, 3 times width R_2/R_{2+3} 1·20 (1·10–1·30), R_1 overlap/R_2 0·54 (0·53–0·61). Aedeagus very pale except at base. Paramere with beaked and swollen tip. Coxite with discrete dense patch of about 95 stout hairs. Style broad at centre, with a small seta at about 0·37, setae at about 0·44 and 0·6, and two at tip.

Material examined.
West Malaysia: Gunong Besout Forest Reserve, 19.x.1973 and 15.vi.1974 (*J. Jeffery*), 3 ♂; Punjong Rabok, 17 and 27.xi.1968 (*A. Rudnick*).

Sergentomyia (*Neophlebotomus*) *chakravarti* (Mitra) **comb. n.**

(Map 8)

Phlebotomus chakravarti Mitra, 1953*b* : 158. Holotype ♀, India (Armed Forces Medical College, Poona, apparently lost, according to V. Dhanda, 1970, in letter) [not examined].

The female has about 14 cibarial teeth on a line angular at the centre, and seven round teeth behind the hind ones.

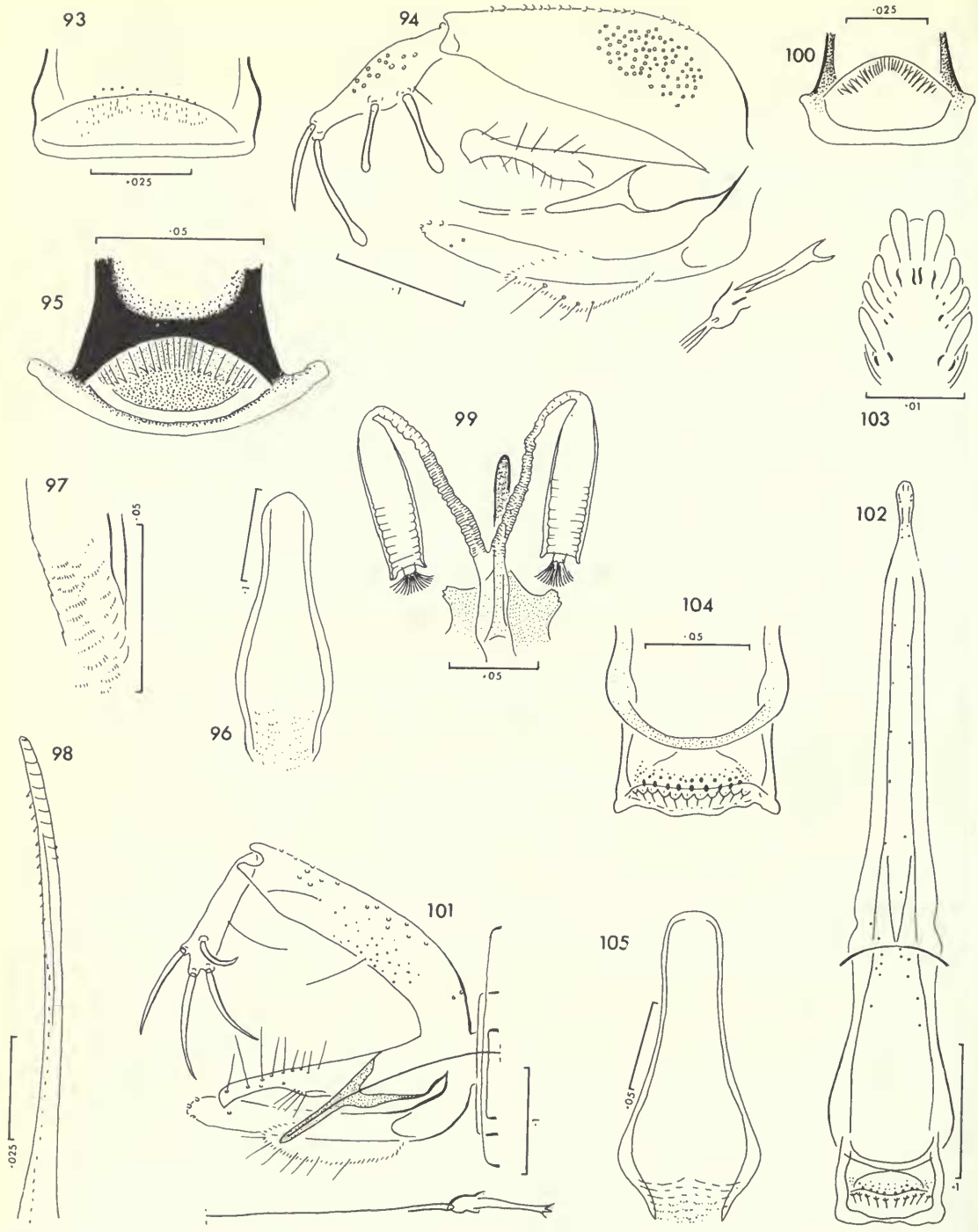
Distribution. **India:** Hoora (Mitra, 1953*b* : 158).

Sergentomyia (*Neophlebotomus*) *dhandai* Lewis **sp. n.**

(Figs 95–101, Map 8)

This species differs from *S. hodgsoni* in having more cibarial hind teeth.

♀. Labrum 0·22 (0·21–0·23) mm long, 0·10 (0·10–0·11) length of wing. Cibarium with about 24 contiguous pointed teeth on a deep arc, and a broad pigment patch, cuticle at base of teeth very dark, and chitinous arch inapparent; salivary pump wide. Pharynx with faintly spiculate ridges. Hypopharynx with low undulations. Antenna 3 = 0·27 (0·24–0·29) mm long, 0·13 (0·11–0·14) length of wing, 1·13 (1·03–1·23) length of 4+5, 1·21 (1·15–1·28) length of labrum, two ascoids on segments 3–15, that on 4 = 0·5 of its length. Maxilla with 11 lateral and 36 short broad ventral teeth, dental depth 0·11 mm; palpal ratio 10 : 21 : 35 : 37 : 85, segment 3 with clavate sensilla bunched on basal half. Scutum and much of pleura dark. Wing length 2·13 (2·11–2·15) mm, 3·3 times width, R_2/R_{2+3} 1·40 (1·27–1·53), R_1 overlap/R_2 0·58 (0·58–0·58). Femur 1 with six large sockets and at least three spines, femur 2 with five large sockets. Hind leg in holotype, lengths in mm: femur 0·44; tibia, 0·57; basitarsus, 0·27; whole, 1·68. Spermatheca



Figs 93–105 *Sergentomyia* species. 93, 94, *S.* Besout sp. ♂, cibarium and terminalia. 95–101, *S. dhandai*: (95–99) ♀, cibarium, pharynx, maxilla and spermatheca; (100, 101) ♂, cibarium and terminalia. 102–105, *S. gemmea*, ♀: (102, 103) labrocibarium and tip of labrum; (104) cibarium; (105) pharynx.

subcylindrical with slightly expanded tip, thick walls and faint internal wrinkles which are sometimes invisible; knob short and cylindrical; ducts faintly striated and joining a common duct.

♂. Labrum 0·18 (0·18–0·18) mm long, 0·11 (0·10–0·11) length of wing. Cibarium with about 24 pointed teeth on a deep arc, no pigment patch. Pharynx almost unarmed. Antenna 3 = 0·28 (0·27–0·29) mm long, 0·16 (0·15–0·17) length of wing, 1·11 (1·11–1·11) length of 4+5, 1·54 (1·46–1·63) length of labrum, one ascoid on segments 3–14 (15 lacking), that on 4 about 0·36 of its length. Wing length 1·72 (1·71–1·74) mm, 3·7 times width, $R/_2R_{2+3}$ 1.41 (1·21–1·62), R_1 overlap/R_2 0·55 (0·51–0·59). Femur 1 with four spines, femur 2 with at least one. Aedeagus with rounded bluntly pointed tip. Filament 4·5 times length of pump. Style with two of spines subterminal at different levels, and seta at 0·6.

Comments. *S. dhandai* apparently differs from *S. chakravarti*, from the same general area, in having more cibarial teeth, a different pigment patch, and no teeth behind the main row. Such differences could conceivably be due to different mounting methods, but the shorter leg of *S. dhandai* in a rather larger fly (with longer antenna 3 and wing) indicates that they are different species.

Material examined.
Holotype ♀, **India:** Poona district, Bhor Ghat, 27.ix.1969 (*S. N. Guttikar, G. B. Modi & P. V. M. Mahadev*), tree hole in hilly woodland (BMNH).

Paratypes. **India:** same data, 1 ♀, 2 ♂ (BMNH). Other specimens, examined by Dr V. Dhanda, are in the Virus Research Centre, Poona.

Sergentomyia (*Neophlebotomus*) *gemmea* Lewis & Jeffery **sp. n.**

(Figs 102–113, Map 9)

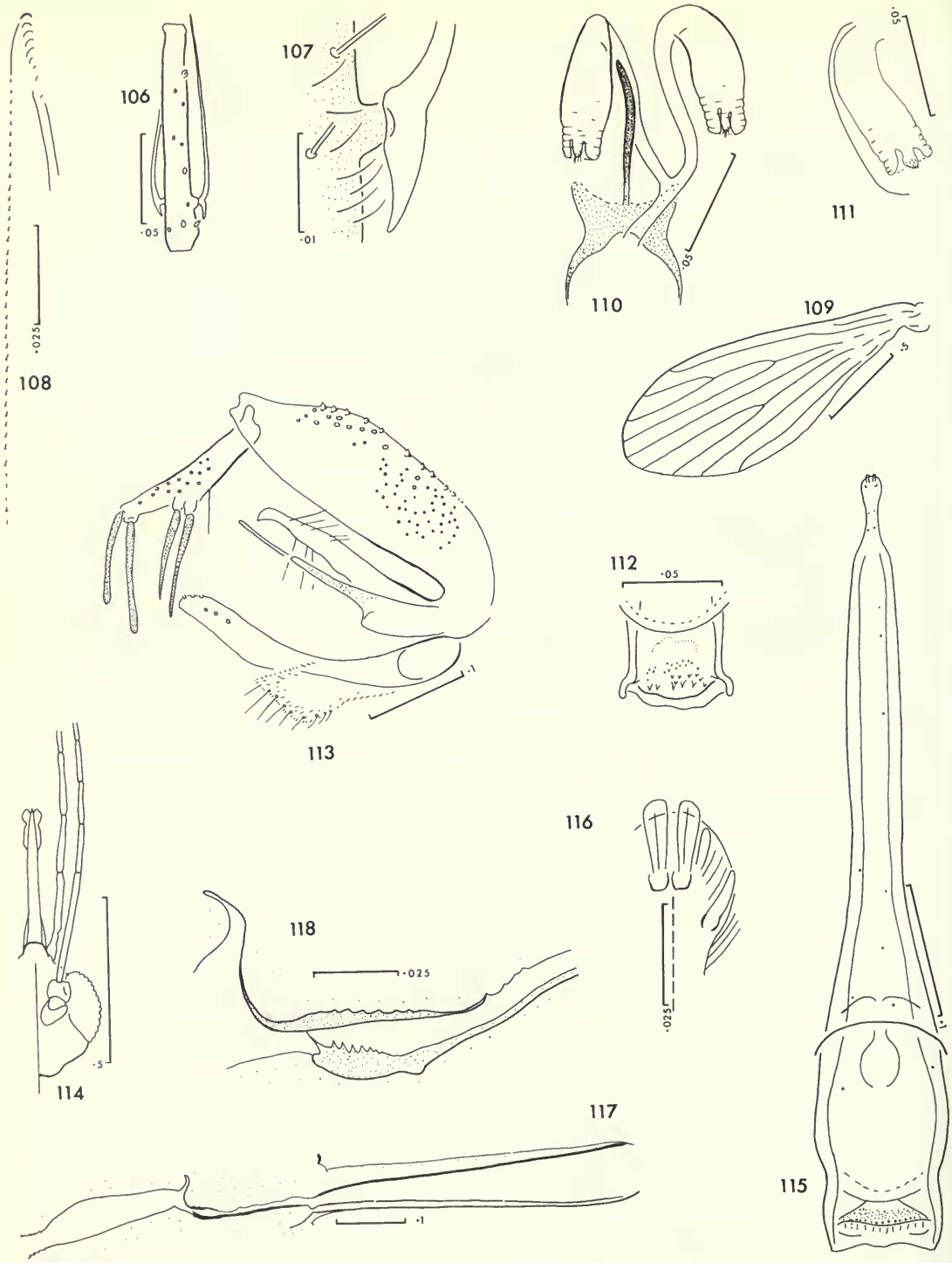
The large size of some of the cibarial fore teeth characterizes this species. The name, meaning jewelled, indicates their ornamental appearance.

♀. Labrum 0·32 (0·29–0·34) mm long, 0·16 (0·15–0·17) length of wing, apical sensilla normal, adorals small. Cibarium with ten hind teeth with broad bases narrowing abruptly to fine points, with one row of eight very large fore teeth, two rows of small teeth in front of them, and a patch of small fore teeth at each side; pigment patch pale; arch strong. Pharynx with linear and with finely spiculate ridges. Hypopharynx with distinct teeth wider than high. Antenna 3 = 0·36 (0·34–0·39) mm long, 0·18 (0·18–0·20) length of wing, 1.26 (1·22–1·31) length of 4+5, 1·13 (1·08–1·19) length of labrum; two ascoids on segments 3–15, that on 4 = 0·87 length of segment and reaching next one, with spur; no papilla on 5. Mandible pointed. Maxilla with about eight lateral teeth and about 41 ventrals, a few of them very small, dental depth 0·12 mm, palpal ratio 10 : 16 : 31 : 34 : 61. Scutum pale brown and pleura mainly pale. Wing length 1·95 (1·98–2·00) mm, 2·7 times width, R_2/R_{2+3} 1·41 (0·99–1·72), R_1 overlap/R_2 rather constant near 0·61 (0·52–0·68). Abdominal tergites 3–6 with a few erect hairs on hind margins. Spermatheca narrow with some wrinkles proximally, with knob in deep narrow pit, delicate ducts uniting into short common one.

♂. Labrum 0·22 mm long, 0·13 length of wing. Cibarium with about six irregular hind teeth and about 20 irregular fore teeth of which a few posterior ones are slightly larger than the others; pigment patch indefinite. Pharynx with faint ridges. Antenna 3 = 0·35 mm long, 0·21 length of wing, 1·21 length of 4+5, 1·59 length of labrum, one ascoid on segments 3–15, that on 4 0·64 length of segment; no papilla on 5. Wing length 1·64 mm, 3 times width, R_2/R_{2+3} 1·01, R_1 overlap/R_2 0·19. Genital filament 3·1 times length of pump. Coxite broad with patch of about 43 narrow hairs merging into large meso-dorsal hairs; style with seta at 0·65 and two of stout spines at about 0·68.

Material examined.
Holotype ♀, **West Malaysia:** Gunong Besout Forest Reserve, 20.iii.1974 (*A. B. Knudsen & colleagues*) (BMNH).

Paratypes. **West Malaysia:** Pulau Meranti, 19.xi.1970, 11.ii.1971 (*S. Mahadevan*), trap baited with monkey *Macaca nemestrina* (beroks) in swamp forest canopy 8·5 m above ground, 19·00–21.00 hours, 2 ♀; as for holotype, 22.ii.1974 (*J. Jeffery & colleagues*), 1 ♀, 1 ♂; Klang, 1.iii.1972 (*D. J. Lewis*), 1 ♀; Tanjong Rabok, 12.xi.1969 (*A. Rudnick*), 1 ♀. (All in BMNH.)



Figs 106–118 *Sergentomyia* species. 106–113, *S. gemmea*: (106, 107) ♀, antenna 4; (108) ♀, maxilla; (109) ♀, wing; (110, 111) ♀, spermathecae; (112, 113) ♂, cibarium and terminalia. 114–118, *S. gombaki*, ♀: (114) head; (115, 116) labrocibarium and tip of labrum; (117, 118) sagittal section of fascicle and cibarium.

Sergentomyia (*Neophlebotomus*) *gombaki* (Lewis & Wharton) **stat. n.**

(Figs 114–126, Map 9)

Phlebotomus sp. Lewis, 1957 : 167.
Phlebotomus (*Sergentomyia*) *zeylanica gombaki* Lewis & Wharton, 1963 : 121. Holotype ♀, West Malaysia (BMNH) [examined].
Sergentomyia (*Rondanomyia*) *zeylanica gombaki* (Lewis & Wharton) Lewis, 1973*a* : 251.

The cibarium of the female has about eight rows of fore teeth and the process of the pigment patch is faint or absent. The labrum is so long that the species looks superficially rather like a *Phlebotomus*. The male is described for the first time.

♀. Labrum 0·40 (0·34–0·42) mm long, 0·20 (0·18–0·21) length of wing, first and last apical sensilla prominent and adorals small. Cibarium with 12 pointed teeth and about seven rows of fore teeth; pigment patch very large and rounded anteriorly. Pharynx with faint ridges. Hypopharynx with low teeth and a smooth tip. Antenna 3 = 0·35 (0·31–0·38) mm long, 0·17 (0·16–0·18) length of wing, 1·26 (1·20–1·34) times length of 4+5, 0·88 (0·83–0·90) length of labrum, two ascoids on 3–15, that on 4 = 0·7 length of segment, with a spur, no papilla on antenna 5. Mandible with about 130 teeth including proximal faint ones, pointed. Maxilla with seven broad lateral teeth and 70 ventrals, dental depth 0·21 mm; palp delicate and difficult to measure, approximate ratio 10 : 20 : 22 : 23 : 57. Scutum brown and pleura mainly pale. Wing length 2·01 (1·97–2·09) mm, 3·1 times width, R_2/R_{2+3} 1·27 (1·07–1·62), R_1 overlap/R_2 0·64 (0·57–0·69). Spermatheca oblong with no collar, and ductules entering deep pit.

♂. Labrum 0·27 (0·25–0·29) mm, 0·14 (0·14–0·15) length of wing. Cibarium with about 16 hind teeth in groups of two or three, and about 16 scattered fore teeth. Pharynx with faint ridges. Antenna 3 = 0·44 (0·41–0·46) mm long, 0·23 (0·21–0·25) length of wing, 1·15 (1·09–1·19) times length of 4+5, 1·62 (1·53–1·70) times length of labrum, one ascoid on segments 3–15, that on 4 = 0·4 of its length. Palpal ratio 10 : 35 : 42 : 42 : 74. Wing length 1·92 (1·83–1·97) mm., 3·6 times width, R_2/R_{2+3} 0·79 (0·48–1·09), R_1 overlap/R_2 0·52 (0·38–0·61). Aedeagus pointed. Paramere beaked. Coxite delicate with sub-basal dense patch of about 183 hairs. Style with two spines terminal and two at 0·6, and a seta at 0·5.

Material examined.
West Malaysia: Gunong Besout Forest Reserve, April 1973 to August 1974 (*A. B. Knudsen & colleagues*), 294 ♀, 218 ♂, 10 of each measured.

Distribution. **West Malaysia:** Bukit Ibam (*L. W. Quate*, via BPBM); Gunong Besout area (as above); Ulu Gombak (Lewis & Wharton, 1963 : 121); Batang Padang, 3.vi.1923, 700 m (*H. M. Pendlebury*).

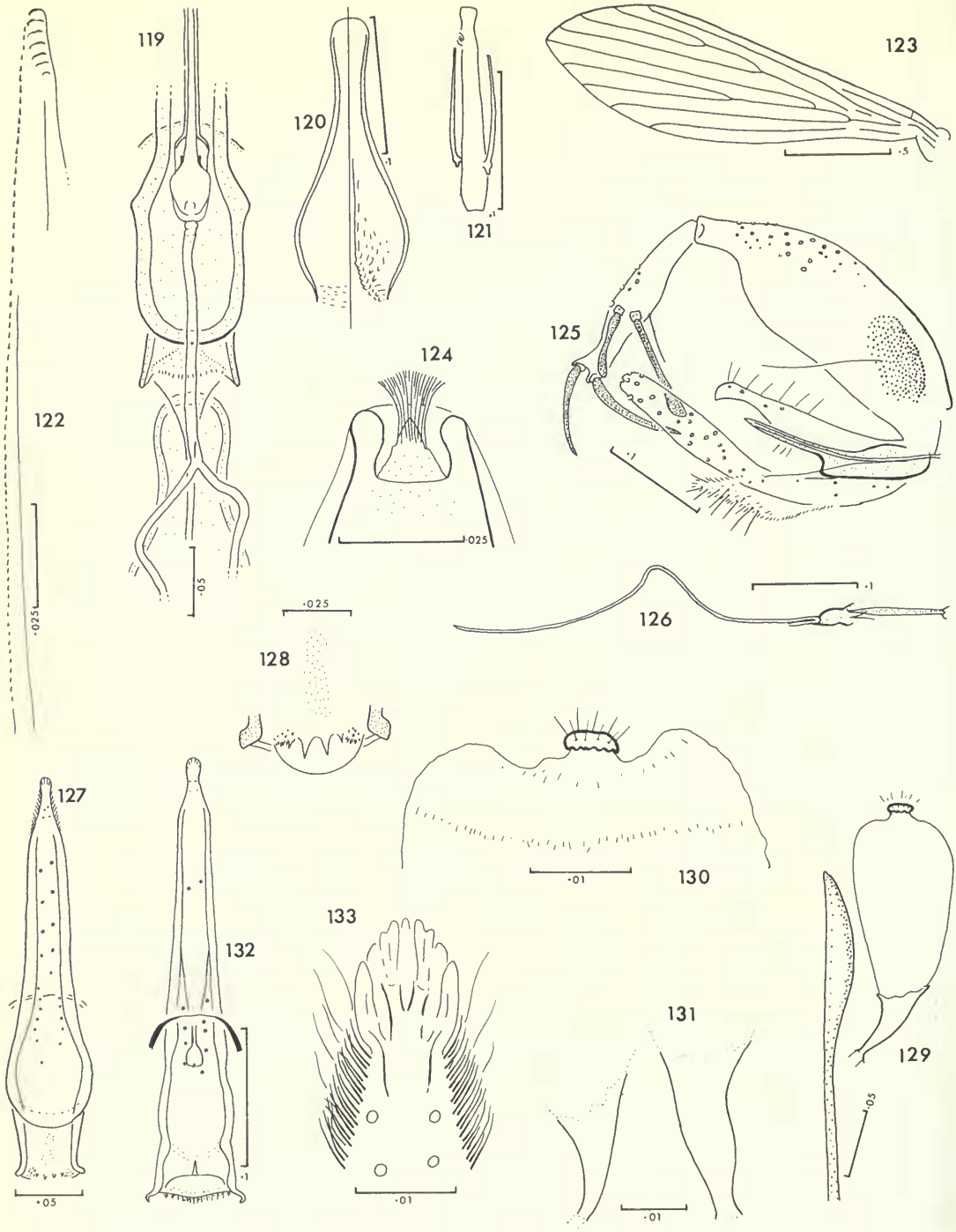
Sergentomyia (*Neophlebotomus*) *hamidi* Lewis & Jeffery **sp. n.**

(Figs 127–131, Map 9)

The female has a cibarium rather like those of *S. quatei* and *S. silvatica*, but different spermathecae.

♀. Eye 0·67 length of head. Labrum 0·16 (0·15–0·17) mm long, 0·09 (0·08–0·09) length of wing, adoral sensilla large. Cibarium with about two to four main spiky teeth, more or less continuous with a group of about ten small teeth at each side, pigment patch elongated and pale. Pharynx with a few lines and spicules. Hypopharynx with low undulations. Antenna 3 = 0·36 (0·35–0·36) mm long, 0·19 (0·19–0·20) length of wing, 0·78 (0·74–0·82) length of 4+5, 2·25 (2·19–2·29) length of labrum, two delicate ascoids, difficult to see, on segments 3–15, that on 4 being 0·28 length of segment, no papilla on 5. Mandible rather blunt, with large main teeth, 1·7 μm wide and very small distal ones. Maxilla with 12 lateral and 24 ventral teeth, dental depth 0·08 mm, palpal ratio 10 : 15 : 30 : 17 : 39. Scutum brown and pleuron brownish. Wing length 1·85 (1·79–1·90) mm, about 3·4 times width, R_2/R_{2+3} 0·85 (0·72–0·97), R_1 overlap/R_2 0·44 (0·33–0·53). Spermatheca with faint ductules, a refractive knob, very thin walls with minute spiculiform specks, narrowing toward the duct which begins as a relatively thick-walled funnel.

Material examined.
Holotype ♀, **West Malaysia:** Gunong Besout Forest Reserve, 29.v.1974 (*Ahmad bin Abd. Hamid*) (BMNH).
Paratypes. Same locality, 18.iii.1974 (*A. B. Knudsen et al.*), 1 ♀; 13.vi.1974 (*J. Jeffery et al.*), 1 ♀; 1974 (*R. B. Tesh*), 2 ♀. (Two in BMNH, two in U.S. National Museum.)
Non-paratypic material. **West Malaysia:** Bukit Ibam (*L. W. Quate*, via BPBM).



Figs 119–133 *Sergentomyia* species. 119–126, *S. gombaki*: (119) ♀, cibarium and base of pharynx; (120) ♀, pharynx; (121) ♀, antenna 4; (122) ♀, maxilla; (123) ♀, wing; (124) ♀, tip of spermatheca; (125, 126) ♂, terminalia and pump. 127–131, *S. hamidi*, ♀: (127, 128) labrocibarium and cibarium; (129–131) spermatheca and ends. 132, 133, *S. iyengari*, ♀, labrocibarium and tip of labrum.

Sergentomyia (*Neophlebotomus*) *hodgsoni* (Sinton)

Phlebotomus hodgsoni Sinton, 1933*a* : 874.

The cibarium of the female has 42–68 teeth, and the paramere of the male bears a spinose process. The species occurs from Central Asia to western India.

Sergentomyia (*Neophlebotomus*) *hodgsoni hodgsoni* (Sinton)

(Map 9)

Phlebotomus hodgsoni Sinton, 1933*a* : 874; 1933*d* : 226; 1933*e* : 419. Lectotype ♀, PAKISTAN (BMNH), designated by Lewis, 1967 : 37 [examined].
Sergentomyia (*Rondanomyia*) *hodgsoni* (Sinton); Theodor & Mesghali, 1964 : 296.
Sergentomyia (*Rondanomyia*) *pawlowskyi hodgsoni* (Sinton); Lewis, 1967 : 37.
Sergentomyia (*Rondanomyia*) *hodgsoni hodgsoni* Artemiev, 1976*a* : 39.

The cibarium of the female has 50–60 teeth, and the paramere of the male bears a ventral spinose process.

DISTRIBUTION. **India:** Mahasu area (Rao *et al.*, 1973). **Pakistan:** Cherat, Gwadi, Jandola, Landi Kotal, Parkuta, Peshawar, Rawalpindi, Said Pur, Taxla (Lewis, 1967 : 38).

Sergentomyia (*Neophlebotomus*) *iyengari* (Sinton) **comb. n.**

(Figs 132, 133, Map 9)

Phlebotomus iyengari Sinton, 1932*c* : 221; Raynal & Gaschen, 1935*c* : 507 [♀]; Raynal, 1935*b* : 249, 294; Theodor, 1938*a* : 268; 1938*b* : 172 [*S. dureni* (Parrot) of Africa as possible variety]. Syntypes 2 ♀, INDIA (depository unknown) [not examined].
Phlebotomus hivernus Raynal & Gaschen, 1935*d* : 582. Syntypes 4 ♀, 4 ♂, VIETNAM (NORTH) (depository unknown) [not examined]. [Synonymized by Quate, 1962*b* : 265.]
Phlebotomus hibernus Anonymous, 1935 : 779 [unjustified emendation under ICZN Article 33a(ii)]; Raynal, 1935*b* : 236, 239; Parrot, 1940 : 311.
Phlebotomus iyengari var. *hivernus* (Raynal & Gaschen) Theodor, 1938 : 267.
Phlebotomus iyengari var. *malayensis* Theodor, 1938 : 266. Syntypes 5 ♀, 17♂, WEST MALAYSIA (depository unknown) [not examined]. [Synonymized by Quate, 1962*b* : 265.]
Phlebotomus (*Prophlebotomus*) *hibernus* Anonymous; Parrot, 1940 : 311.
Phlebotomus iyengari var. *hainanensis* Yao & Wu, 1940 : 786; 1941 : 77; Leng, 1964 : 121, 128. Syntypes 3 ♀, CHINA (depository unknown) [not examined]. [Synonymized by Quate, 1962*b* : 265, 266.]
Phlebotomus (*Prophlebotomus*) *iyengari* Sinton; Parrot, 1946 : 70; Parrot & Clastrier, 1952 : 159.
Phlebotomus (*Sergentomyia*) *iyengari* var. *malayensis* Theodor; Lewis, 1957 : 168.
Phlebotomus (*Sergentomyia*) *iyengari* Sinton; Quate, 1962*b* : 265.
Phlebotomus (*Sergentomyia*) *iyengari taiwanensis* Cates & Lien, 1970 : 530. Holotype ♀, TAIWAN (Taiwan Malaria Research Institute) [not examined]. **Syn. n.**
Sergentomyia (*Rondanomyia*) *iyengari* (Sinton); Lewis, 1973*a* : 250; Yen-Chia, 1977 : 336.

The cibarium of the female has the central teeth smaller than the rest, fore teeth absent or ranging from one row of four to two rows of up to 20, and a pigment patch with forward projection thick, small or absent.

Theodor (1938) pointed out that this species is related to *S. dureni* (Parrot) of Africa. *S. iyengari*, like *S. tambori*, somewhat resembles the African *S. decipiens* (Theodor) and *S. dureni* but has a very pronounced spermathecal collar.

In a female from Gunong Besout, the labral apical sensilla are clearly visible and there are few anterior adorals, the hypopharynx has a few very low serrations, the mandible is normal, and the maxilla has eight broad lateral teeth, 26 well-marked ventrals and a dental depth of 0·10 mm.

The extra ascoids in the male, mentioned by Parrot (1940), are narrow with small bases and resemble colourless spines near the tips of segments 8–16 and on antennae of some other species. They are perhaps best regarded as vestiges to be excluded from the antennal formula.

The form *taiwanensis* is treated here as a synonym in view of Quate's conclusions on variation in the species. Yen-Chia (1977) recognizes *S. hainanensis* as a species with *malayensis* as its synonym.

MATERIAL EXAMINED.
West Malaysia: Gunong Besout Forest Reserve, 1973–74 (*A. B. Knudsen, J. Jeffery & colleagues*), 24 ♀, 18 ♂.

DISTRIBUTION. **China:** Hainan Island (Leng, 1964 : 127); Aihsien (Yao & Wu, 1940 : 797); Lingshui, Paoting (Yao & Wu, 1941*b* : 77). **India:** Trivandrum (Sinton, 1933*e* : 221). **Laos:** Luang-Prabang (Parrot & Clastrier, 1952 : 153); Muong Sing (Quate, 1962*b* : 265). **Taiwan:** many lowland places except west coastal plain, Hua-lien area, Kao-hsiung area, Taipei area (Cates & Lien, 1970 : 531). **Thailand:** Chieng Mai, Doi Sutep, Khon Kaen Province, Nong Khai area, Sara Buri, Tha Li area, Udon Thani area (Quate, 1962*b* : 265). **Vietnam (North):** Bim Son, Cho Ganh (Raynal, 1935*b* : 253, 297). **West Malaysia:** Gunong Besout area (as above); Kuala Lumpur area, Ulu Gombak (Lewis, 1957 : 168); Selangor State (Theodor, 1938 : 267).

In Indo-China Raynal (1936*a* : 361) at first found *S. iyengari* in only one locality (occasionally at the start of the warm season), and in the north (1936*a* : 367) encountered it only on mountain spurs about 20° north in the cold season.

Sergentomyia (*Neophlebotomus*) *jefferyi* Lewis **sp. n.**

(Figs 134–142, Map 9)

The female differs from *S. hitchensi* in having a prominent pigment patch.

♀. Eye 0·55 length of head. Labrum 0·19 (0·17–0·20) long, 0·11 (0·11–0·13) length of wing, apical sensilla very delicate, and subapicals hardly visible, adorals reduced. Cibarium with seven or eight delicate hind teeth and about ten fore teeth in single row; pigment patch about half internal width of cibarium, broader in front than behind, reddish brown, a faint short broad patch in front of it in ventral wall. Pharynx with faint lines. Hypopharynx with very low teeth which approach the tip. Antenna 3 = 0·25 (0·24–0·28) mm long, 0·15 (0·15–0·16) length of wing, 1·18 (1·10–1·20) length of 4+5, 1·36 (1·32–1·45) length of labrum, two ascoids on segments 3–15, that on 4 very thin and about 0·8 length of segment, no papilla on 5. Mandible pointed. Maxillary teeth vestigial; palpal ratio 10 : 20 : 31 : 50 : 74. Scutum pale brown and pleura pale. Wing length 1·69 (1·58–1·75) mm, 3·3 times width, R_2/R_{2+3} 0·96 (0·74–1·15), R_1 overlap/R_2 0·46 (0·29–0·57). Spermatheca usually wrinkled, with a rather low knob in a deep pit.

♂. Labrum 0·16 (0·15–0·17) mm long, 0·11 (0·11–0·12) length of wing. Cibarium with about seven ill-defined hind teeth, and about 15 small fore teeth in irregular row. Pharynx unarmed. Antenna 3 = 0·25 (0·22–0·27) mm long, 0·17 (0·16–0·20) length of wing, 1·16 (1·01–1·23) length of 4+5, 1·55 (1·41–1·71) length of labrum, one ascoid on segments 3–15, that on 4 about 0·33 length of segment, and small transparent hairs on some of distal segments. Wing length 1·44 (1·38–1·50) mm, 3·6 times width, R_2/R_{2+3} 0·72 (0·53–0·85), R_1 overlap/R_2 0·30 (0·18–0·41). Coxite and style with few hairs, seta on style small.

MATERIAL EXAMINED.
Holotype ♀, **West Malaysia:** Perak, Gunong Besout Forest Reserve, 5.v.1974 (*J. Jeffery*) (BMNH).
Paratypes. Same locality, 24.ii.1974 to 10.viii.1974, 12 ♀, 10 ♂, ten of each measured. (All in BMNH.)

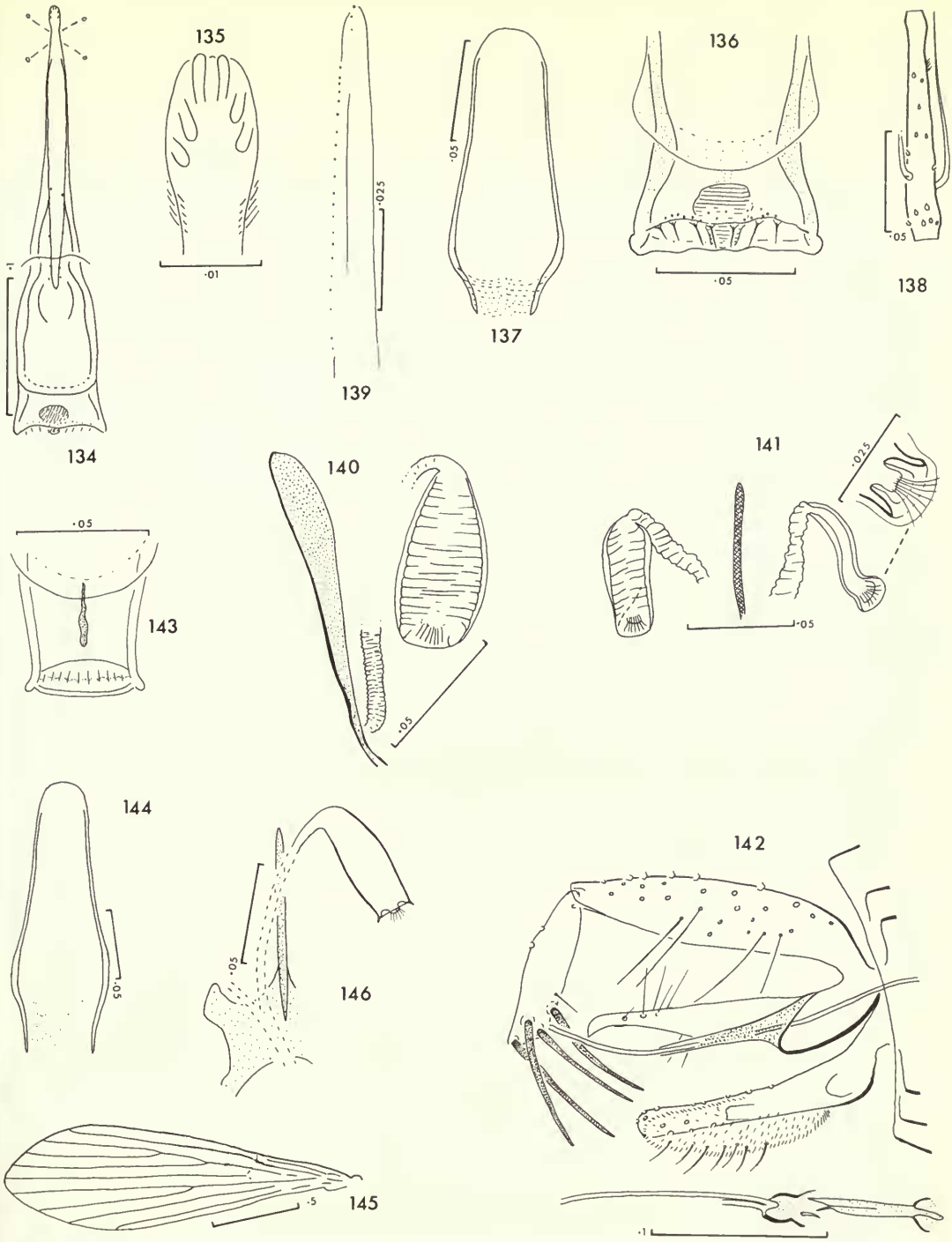
Sergentomyia (*Neophlebotomus*) *khawi* (Raynal)

(Map 9)

Phlebotomus khawi Raynal, 1936*c* : 529; 1937 : 72; Yao & Wu, 1941*b* : 77. Syntypes ♀ ♂, CHINA (depository unknown) [not examined].
Phlebotomus (*Prophlebotomus*) *khawi* Raynal; Parrot & Clastrier, 1952 : 160.
Sergentomyia (*Rondanomyia*) *khawi* (Raynal); Theodor, 1958 : 48; Lewis, 1973*a* : 251.
Phlebotomus (*Sergentomyia*) *khawi* Raynal; Quate, 1962*b* : 265.

The cibarium of the female has no pigment patch and a row of contiguous teeth, convex at the centre.

DISTRIBUTION. **Cambodia:** Phnom Penh (1 ♂, Parrot & Clastrier, 1952 : 133).



Figs 134–146 *Sergentomyia* species. 134–142, *S. jefferyi*: (134–136) ♀, labrocibarium, tip of labrum and cibarium; (137) ♀, pharynx; (138) ♀, antenna 4; (139) ♀, maxilla; (140, 141) ♀, spermatheca; (142) ♂, terminalia. 143–146, *S. linearis*, ♀: (143, 144) cibarium and pharynx; (145) wing; (146) spermatheca.

Sergentomyia (*Neophlebotomus*) *linearis* Lewis **sp. n.**

(Figs 143–148, Map 9)

A long narrow pigment patch in the cibarium distinguishes females and males from those of most other species of *Sergentomyia*.

♀. Labrum 0·25 (0·24–0·26) mm long, 0·12 (0·12–0·12) length of wing. Cibarium with about 10–12 pointed teeth in nearly straight row, and no fore teeth; pigment patch narrow and linear. Pharynx with faint ridges. Hypopharynx smooth. Antenna 3 = 0·34 (0·32–0·36) mm long, 0·16 (0·16–0·17) length of wing, 1·26 (1·21–1·32) length of 4+5, 1·36 (1·31–1·40) length of labrum; two ascoids on segments 3–15, that on 4 = 0·73 length of segment; no papilla on 5. Maxilla with no lateral teeth and vestigial ventrals; palpal ratio 10 : 24 : 32 : 39. Wing length 2·06 (2·00–2·19) mm, about 3·3 times width, R_2 (very long)/R_{2+3} 2·40 (2·16–2·66), R_1 overlap (consistently very long)/R_2 0·75 (0·73–0·76). Spermatheca subcylindrical, with collar and delicate duct.

♂. Labrum 0·18 (0·17–0·21) mm long, 0·11 (0·10–0·13) length of wing. Cibarium with about 12 pointed divergent teeth and no fore teeth, pigment patch linear. Pharynx almost unarmed. Antenna 3 = 0·35 (0·31–0·43) mm long, 0·20 (0·19–0·20) length of wing, 1·21 (1·07–1·30) length of 4+5, 1·89 (1·77–2·07) length of labrum, one ascoid on segments 3–15, that on 4 = 0·55 length of segment. Wing length 1·76 (1·67–2·18), 3·5 times width, R_2/R_{2+3} 2·03 (1·61–2·64), R_1 overlap/R_2 0·73 (0·65–0·96). Genital filament about 2·6 times length of pump. Aedeagus tapering to a blunt point. Coxite with about ten scattered hairs in brush. Style short and narrow, with seta at 0·75 and two of spines subterminal.

The specimens were presented to the BMNH by J. A. Sinton who had labelled them *linearis*, presumably with reference to the pigment patch.

Material examined.
Holotype ♀, **India:** Travancore, Kolatupuzha (= Kulathurpuzha ?) Forest Reserve, ix(?). 1934 (*M. O. T. Iyengar*), tree holes (BMNH).

Paratypes. **India:** data as for holotype, 3 ♀, 19 ♂; 6 ♀, 10 ♂ measured; Palod Forest Reserve, ix(?).1934 (*M. O. T. Iyengar*), 2 ♀, 9 ♂. (All in BMNH.)

Non-paratypic material. **India:** Kannur, ix, x.1957 (*H. Trapido*). (In BMNH.)

Sergentomyia (*Neophlebotomus*) *malabarica* (Annandale) **comb. rev.**

(Figs 149–156, Map 9)

Phlebotomus malabaricus Annandale, 1910*b* : 48; Brunetti, 1912 : 214; Sinton, 1924*a* : 833; 1924*c* : 1007 [♂ measurements & figs]; 1928*c* : 321; 1931*e* : 110; 1935*e* : 420, 423; Mitra, 1953 : 162. Lectotype ♂, India (Zoological Survey of India), designated by Quate, 1962*c* : 158 [not examined].
Sergentomyia malabarica (Annandale); Theodor, 1948 : 111 [put in *africana* group].
Phlebotomus (*Sergentomyia*) *malabaricus* Annandale; Quate, 1962*c* : 158.

The cibarium of the female has about eight hind teeth in a nearly straight row.

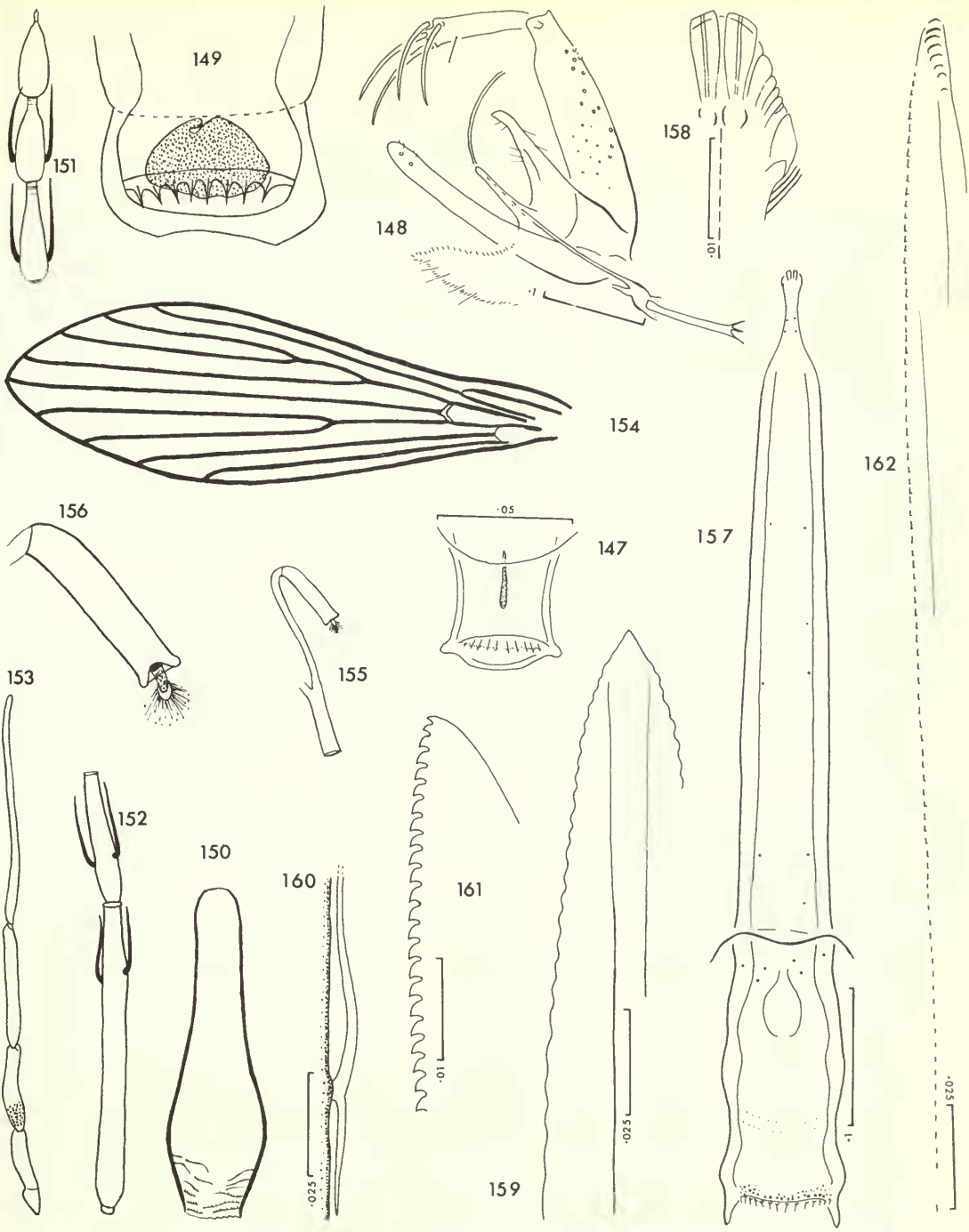
♀. Medium-sized and very dark brown. Labrum 0·20 (0·17–0·23) mm long. Cibarium with eight pointed teeth and a distinct pigment patch. Pharynx almost unarmed. Antenna 3 = 0·28 (0·27–0·29) mm long, 1·16 (1·11–1·20) length of 4+5, 1·42 (1·25–1·64) length of labrum, ascoid on 4 about 0·56 length of segment. Palpal ratio 10 : 21 : 34 : 48 : 90. Wing length 2·06 (1·94–2·23) mm, 3·5 times width, R_2/R_{2+3} 2·51 (2·35–2·61), R_1 overlap/R_2 0·76 (0·74–0·80). Spermatheca tubular.

♂. Described by Sinton (1924*c*).

Comments. *S. malabarica*, described when important characters were still unknown, has for long been a problem species with regard to the structure of the male, the identity of the female, confusion with other species, and suggested use as a type-species (see under *Sergentomyia*).

The male was at first stated to bear spines on the surstyle but these proved to be merely hair-sockets (Sinton, 1924*c*).

Misidentification of the female has occurred (Sinton, 1927*a* : 933; 1927*d* : 25, 1927*e* : 30; 1928*c* : 321; 1932*a* : 61. See under *S. modii*.).



Figs 147–162 *Sergentomyia* species. 147, 148, *S. linearis*, ♂: (147) cibarium; (148) terminalia. 149–156, *S. malabarica*, ♀: (149) cibarium; (150) pharynx; (151, 152) antennal tip and segments 3 and 4; (153) palp; (154) wing; (155, 156) spermatheca. 157–162, *S. malayae*, ♀: (157, 158) labrocibarium and tip of labrum; (159) hypopharynx; (160) base of ascoid on antenna 4; (161) mandible tip; (162) maxilla. (Figs 149–156 J. A. Sinton *del.*)

The female remained unknown till 1934 when Sinton received specimens from Kerala. He left notes in the BMNH from which the above description was prepared.

The species is placed in this subgenus on the basis of the style-spines of the male and the wing and spermatheca of the female.

Slides presented to the BMNH by Sinton and bearing a provisional name *malabarica* included two other species, *S. modii*, which had previously been described as the female of *malabarica*, and *S. kauli*.

DISTRIBUTION. **India:** Travancore (now in Kerala), below western slopes of Western Ghats, Maddathorai and Palod (= Pallode ?) (Annandale, 1910 : 49); Kulathurpuzha Forest Reserve and Palod Forest Reserve, 1934 (*M. O. T. Iyengar*), 4 ♀, 4 ♂.

Sergentomyia (*Neophlebotomus*) *malayae* (Lewis) **stat. n.**

(Figs 157–164, Map 9)

Phlebotomus (*Sergentomyia*) *zeylanica malayae* Lewis, 1957 : 166; Quate & Fairchild, 1961 : 218. Holotype ♀, WEST MALAYSIA (BMNH) [examined].
Sergentomyia (*Rondanomyia*) *zeylanica malayae*; Lewis, 1973*a* : 251.

The female has about three rows of cibarial fore teeth and a very long labrum, 0·18–0·20 of the wing length, and more maxillary ventral teeth than does *S. zeylanica*.

♀. Labrum 0·50 (0·48–0·52) mm long, 0·19 (0·18–0·20) length of wing, with two main apical truncate sensilla, adorals small. Cibarium with 14 teeth and about two or three rows of fore teeth. Pigment patch rounded anteriorly. Pharynx with faint ridges. Hypopharynx (and mandibles) curled like grass, with very low teeth and a smooth tip. Antenna 3 = 0·48 (0·45–0·52) mm long, 0·18 (0·17–0·20) length of wing, 1·23 (1·13–1·28) times length of 4+5, 0·19 (0·88–1·02) length of labrum, two ascoids on segments 3–15, that on 4 delicate with long spur, no papilla on 5. Mandible pointed. Maxilla with eight broad lateral teeth and 88 ventrals, and a dental depth of 0·29 mm, palpal ratios about 10 : 25 : 31 : 25 : 54. Scutum and pleuron mainly pale. Wing length 2·64 (2·53–2·83) mm, 3·0 times width, R_2/R_{2+3} 1·83 (1·53–2·06), R_1 overlap/R_2 0·75 (0·72–0·78), rather constant. Abdominal tergites 5 and 6 with a few hind erect hairs. Spermatheca oblong without collar.

♂. Labrum 0·37 (0·36–0·37) mm long, 0·15 (0·14–0·15) length of wing. Cibarium with about ten irregular hind teeth and about 40 scattered fore teeth. Pharynx with faint ridges. Antenna 3 = 0·61 (0·56–0·63) mm long, 0·25 (0·24–0·26) length of wing, 1·10 (0·98–1·17) length of 4+5, 1·65 (1·59–1·72) length of labrum, one ascoid on segments 3–15, that on 4 with a narrow spur. Wing length 2·47 (2·35–2·55) mm, 3·3 times width, R_2/R_{2+3} 1·81 (1·36–2·11), R_1 overlap/R_2 0·73 (0·70–0·77). Aedeagus bluntly pointed. Genital filaments short. Paramere beaked. Coxite with about 50 hairs in brush which merges gradually into the dorsal thick hairs.

MATERIAL EXAMINED.
West Malaysia: Gunong Besout Forest Reserve, 1973–74 (*A. B. Knudsen, J. Jeffery & colleagues*), 17 ♀, 48 ♂; ten of each measured.

DISTRIBUTION. **West Malaysia:** Gunong Besout Forest Reserve (as above, one with tip of proboscis clogged); Ulu Gombak (Lewis, 1957 : 167).

Sergentomyia (*Neophlebotomus*) *nankingensis* (Ho, Tan & Wu) **comb. n.**

(Map 9)

Phlebotomus nankingensis Ho, Tan & Wu, 1954 : 427. Syntypes 4 ♀, 2 ♂, CHINA: Nanking area, Purple Mountains, 1952 (depository unknown) [not examined].

Of the 14 cibarial hind teeth of the female, one on each side is separated from the rest. The following features are among those given by the author.

♀. Cibarium with 14 hind teeth, the outer two on each side spaced and apart from the rest; a row of 12 fore teeth present; pigment patch pointed in front and notched behind. Pharynx with groups of spicules.

Antenna stated to have one ascoid on 3–15. Palpal formula 1–2–3–4–5. Wing: R_2/R_{2+3} 1·24, R_1 overlap/R_2 0·52. Spermatheca with some distal striations.

♂. Cibarium with eight teeth and a small faint triangular pigment patch. Antenna with one ascoid on segments 3–15. Wing: R_2/R_{2+3} 1·1, R_1 overlap/R_2 0·5. Coxite: persistent hairs not indicated. Style with two of spines at 0·76. Position of seta not shown.

Sergentomyia (*Neophlebotomus*) *perturbans* (de Meijere)

(Figs 165–177, Map 10)

Phlebotomus perturbans de Meijere, 1909 : 201; Sinton, 1924*d* : 1015; 1928*c* : 316, 320; Patton & Hindle, 1926 : 405, 410 [type said to exist in Amsterdam]; 1928 : 533, 542; Edwards, 1928 : 64 [?]. Lectotype ♀, JAVA, designated by Quate, 1967 : 42 (ZMA) [examined].

Phlebotomus sylvestris Sinton, 1924*d* : 1017 [conditional name justified by ICZN Article 17(8)]; 1928*c* : 320; 1931*c* : 1209; 1931*e* : 110; 1932*a* : 62; 1933*e* : 420; Raynal, 1935*b* : 257; 1936*a* : 361 [synonymy]. Syntypes ♀ ♂, INDIA (depository unknown) [not examined]. **Syn. n.**

[*Phlebotomus perturbans* de Meijere; Patton & Hindle, 1926 : 409; 1928 : 542. Misidentification in view of later selection of lectotype.]

Phlebotomus demeijerei Nitzulescu, 1930 : 540. Syntypes 2 ♀, JAVA (depository unknown) [not examined]. [Synonymized (= *sylvestris*) by Theodor, 1948 : 111.]

Phlebotomus (*Prophlebotomus*) *sylvestris* Sinton; Parrot, 1940 : 311; 1946 : 71, 73; Parrot & Clastrier, 1952 : 167.

Phlebotomus (*Sergentomyia*) *whartoni* Lewis, 1957 : 167; Quate & Fairchild, 1961 : 121; Lewis & Wharton, 1963 : 121. Holotype ♀, WEST MALAYSIA (BMNH) [examined]. **Syn. n.**

Phlebotomus (*Sergentomyia*) *sylvestris* Sinton; Quate, 1962*b* : 265 [synonymy].

Phlebotomus (*Sergentomyia*) *perturbans* de Meijere; Quate, 1967 : 42.

Sergentomyia (*Rondanomyia*) *whartoni* (Lewis); Lewis, 1973*a* : 251.

The female differs from all other species in having about nine main cibarial teeth arising from a well-marked refractive area of the ventral wall. The coxite of the male is long, narrow and slightly curved.

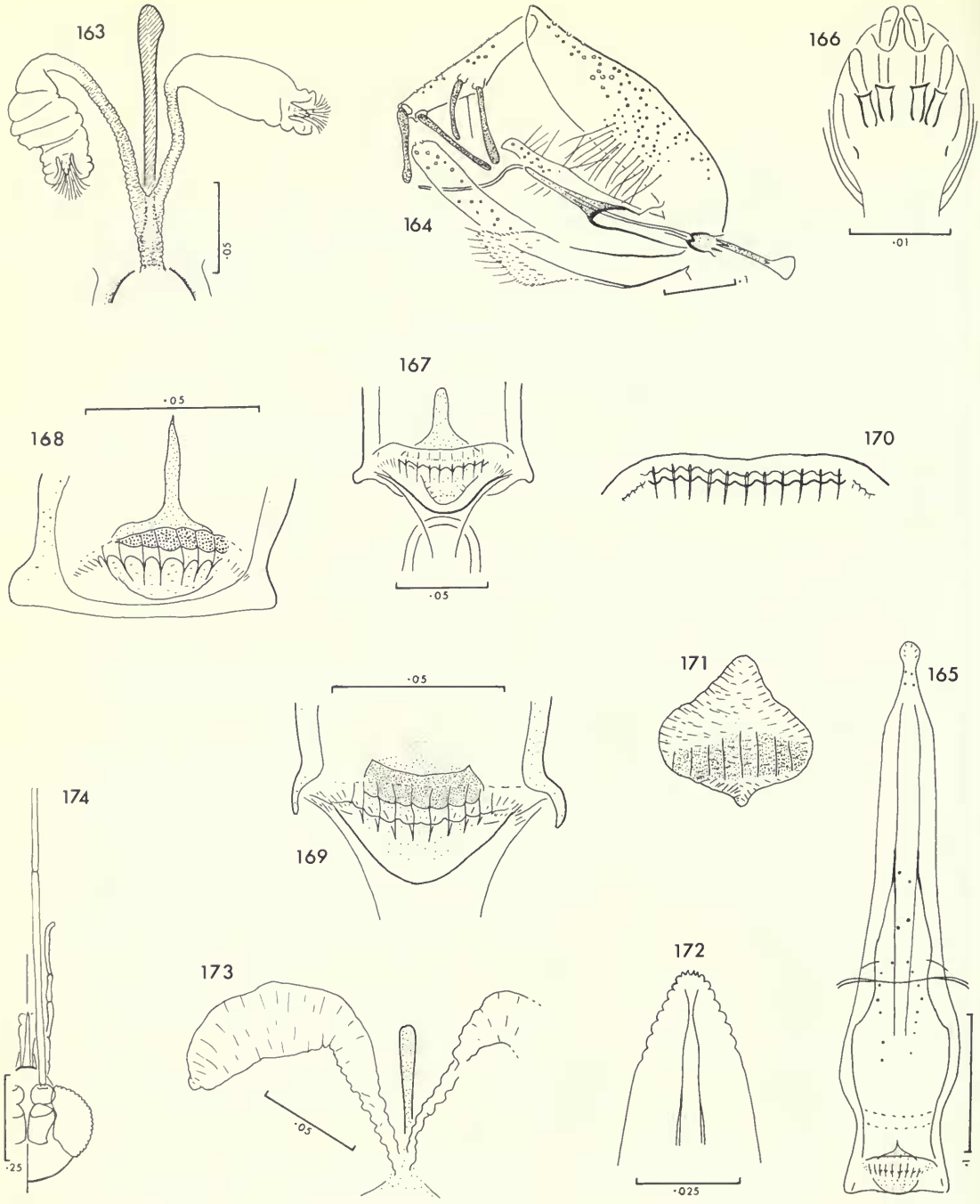
♀. Eye 0·61 length of head. Labrum 0·24 (0·23–0·25) mm long, 0·11 (0·11–0·11) length of wing, first two apical sensilla with conspicuous sockets, adorals well developed. Cibarium with eight or nine distinct pointed teeth merging into about ten spicules on each side, arising from thick refractive band, fore teeth absent, pigment patch dark reddish brown anteriorly and grey posteriorly, with transverse and oblique line, bearing anteriorly about eight longitudinal lines; distinct cibarial bulge present. Pharynx less than twice as wide posteriorly as anteriorly, with faint ridges bearing minute spicules. Hypopharynx with low teeth and a toothed tip. Antenna 3 = 0·36 (0·32–0·39) mm long, 0·16 (0·15–0·17) length of wing, 0·91 (0·85–0·95) length of 4+5, 1·48 (1·38–1·57) length of labrum, two ascoids on segments 3–15, that on 4 with vestigial spur, no papilla on 5. Mandibles nearly pointed. Maxilla with eight broad lateral teeth and 35 well-marked ventrals, and a dental depth of 0·15 mm, palpal ratio 10 : 22 : 30 : 24 : 56. Scutum brown and pleura pale except near coxae. Wing length 2·22 (2·11–2·29) mm, 3·1 times width, R_2/R_{2+3} 0·79 (0·62–0·88), R_1 overlap/R_2 0·47 (0·20–0·67). Abdominal tergites 5 and 6 with a few erect hairs on hind margins. Spermatheca with transverse wrinkles, no collar and a protruding knob.

♂. Labrum 0·18 (0·14–0·20) mm long, 0·91 (0·08–0·10) length of wing. Cibarium with eight irregular denticles of varied shape. Pharynx with faint ridges. Antenna 3 = 0·53 (0·50–0·57) mm long, 0·28 (0·25–0·31) length of wing, 0·78 (0·67–0·85) length of 4+5, 3·14 (2·48–3·78) length of labrum, one ascoid on 3–15. Wing length 1·90 (1·74–2·03) mm, 3·6 times width, R_2/R_{2+3} 0·67 (0·37–0·85), R_1 overlap/R_2 0·36 (0·18–0·44), costal basal node very small. Aedeagus slender and tapering to round point. Paramere beaked. Coxite narrow and curved outward, with diffuse patch of about 40 narrow hairs, and many thick long hairs pointing backward. Style narrow. Genital filaments about four times length of pump.

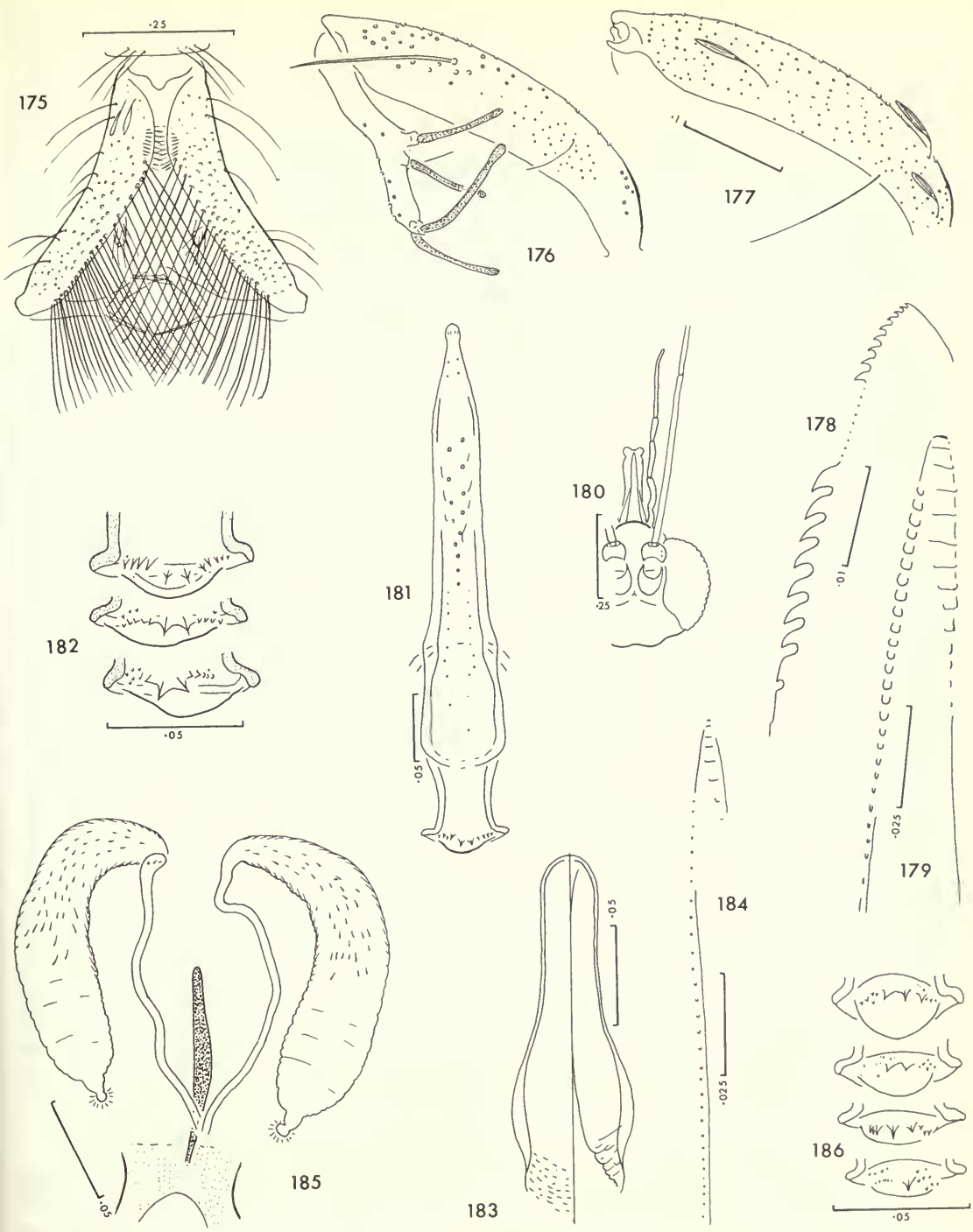
The above description is based on ten of each sex from West Malaysia, Gunong Besout Forest Reserve (1974).

The antenna, very long in this species (Parrot, 1946), and long hairs on the coxite are reminiscent of *P. frondifer* and could indicate life in dark surroundings.

Measurements of four females from Java, namely the lectotype, paralectotype (lacking head) and two from Semarang (ii, iii.1910), are as follows. Labrum 0·26 (0·25–0·27) mm long, 0·12 (0·11–0·12) length of



Figs 163–174 *Sergentomyia* species. 163, 164, *S. malayae*: (163) ♀, spermathecae; (164) ♂, terminalia. 165–174, *S. perturbans*: (165) ♀ (Gunong Besout area), labrocibarium; (166) labrum tip of same; (167) ♀ (Tanjong Rabok), cibarium; (168) ♀, cibarium of lectotype; (169) ♀ (Sukna), cibarium; (170, 171) ♀ (Gunong Besout area), cibarial hind teeth crushed, and isolated pigment patch of same fly; (172) ♀, hypopharynx tip; (173) ♀ (Sukna), spermatheca; (174) ♂ (Gunong Besout area), head.



Figs 175–186 *Sergentomyia* species. 175–177, *S. perturbans*, ♂, terminalia, and coxite in mesad and lateral view. 178, 179, *S. purii*, ♀: (178) mandible; (179) maxilla. 180–186, *S. quatei*: (180) ♀, head; (181) ♀, labrocibarium; (182) ♀, cibarium; (183) ♀, pharynx; (184) ♀, maxilla; (185) ♀, spermathecae; (186) ♂, cibarium.

wing. Antenna 3 = 0·35 (0·33–0·36) mm long, 0·15 (0·15–0·16) length of wing, 0·89 (0·86–0·93) length of 4+5, 1·67 (1·25–1·39) length of labrum. Palpal ratio about 10 : 21 : 28 : 20 : 45. Wing length 2·18 (1·99–2·26) mm long, about 3·3 times width, R_2/R_{2+3} 0·70 (0·59–0·88), R_1 overlap/R_2 0·52 (0·36–0·70). These and other features agree well with flies from West Malaysia.

Measurements of four females from Sukna, India (3.vii.1908), are as follows. Labrum 0·29 (0·27–0·31) mm long, 0·13 (0·12–0·14) length of wing. Antenna 3 = 0·32 (0·29–0·35) mm long, 0·14 (0·13–0·15) length of wing, 0·90 (0·83–0·96) length of 4+5, 1·11 (1·06–1·18) length of labrum. Palpal ratio about 10 : 24 : 32 : 21 : 50. Wing length 2·27 (2·23–2·31) mm, 3·3 times width, R_2/R_{2+3} 0·71 (0·64–0·78), R_1 overlap/R_2 0·45 (0·38–0·48). These figures agree well with data from Java except that antenna 3/labrum is lower, but this could well be due to infraspecific variation.

When *S. perturbans* was named it was probably thought that all sandflies bit man, but there is no evidence that it does so.

Discussion on the cibarium of the female. Nitzulescu (1930) described the cibarial armature of Javanese *S. perturbans* (=*demeijerei*) as a double row of teeth, nine in each, one behind the other. Sinton (1932*a*) studied Indian specimens (=*sylvestris*) and figured about 25 hind teeth on a concave line, and an apparently refractive area (the above-mentioned dark ventral patch) in line with the ten central ones. Raynal (1935*b*) described, in North Vietnam *sylvestris*, 20 strong and very pointed hind teeth and, at the anterior edge of the dark pigment patch, a row of ten or 11 contiguous rectangles, apparently anterior incisor teeth, which were more or less apparent at certain angles during mounting. Raynal & Gaschen (1935*b*) stated that the hind lateral teeth were sometimes difficult to see, and that the rectangles appeared pigmented, apparently owing to the pigment patch on which they were reported to be placed. Parrot & Clastrier (1952), studying specimens (=*sylvestris*) from Cambodia, recognized 13 dimorphic hind teeth, namely nine median long ones, curved slightly inward, and on each side narrow ones which appeared to number two but were hard to see and could be more numerous. They observed the dark rectangles, apparently chitinous thickenings, but could not confirm Raynal's impression of incisor teeth. Quate (1967) described, in Javanese *perturbans*, eight long teeth with bases apparently embedded in a dark nail-shaped pigment patch, with no evident fore teeth, the armature being unlike that of any other Asian species which he knew.

After studying cibaria from the three above-mentioned countries, mounted in Berlese's medium without pressure, and removing the pigment patch from a few specimens, I find that the differences in descriptions are due to several causes. Compression has sometimes increased the number of observed hind teeth. The thick hind part of the inter-arcal area produces a refractive lens-like effect which masks the structure. The lines on the pigment patch (Nitzulescu's first row of 'teeth') have been taken for teeth or bases of teeth; this can easily happen because in a cibarium at rest the arched dorsal and ventral walls are almost in the same optical plane.

The lines on the pigment patch (also seen in *S. reidi*) appear to be imprints of the central cibarial teeth. Among specimens examined in detail were three pinned ones from Sukna, India (3.vii.1908, labelled *P. perturbans*, presented to the BMNH in 1927 by E. Brunetti, and recently slide-mounted). They showed eight cibarial main teeth and, on each side, one vestigial tooth and numerous denticles or spicules such as occur in several species of *Sergentomyia* and could well be disregarded in descriptions. At the bases of the teeth is a dark area which appears to be a thickening of the ventral wall of the cibarium. A hind bulge is conspicuous.

Discussion on synonymy. *S. perturbans* was described at a time when some important taxonomic structures and 98 per cent of the world's sandfly taxa were still unknown. Species in distant lands were wrongly identified as this species, and *S. sylvestris* was treated as a different species, but now proves to be a synonym. For a time workers who examined specimens from de Meijere's collection tended to regard them as one species (they are here shown to comprise at least five), and there was little attempt to distinguish the type-series from other specimens. Two specimens of what proves to be the type-form were described as a new species, *demeijerei*. Confusion has reigned for over 65 years, and has been referred to in part by Patton & Hindle (1928), Sinton (1928*c*), Raynal & Gaschen (1936*c*), Perfil'ev (1968) and Lewis & Dyce (1976).

The situation is clarified, it is hoped, in the following notes on specimens which, except numbers 5, 6, 15 and 16, are in the ZMA. All were collected in Java in 1908, 1909 and 1910 by Edward Jacobson (a private collector who lived in Djakarta, then Batavia, and Semarang) and are females except number 6.

1. *P. stantoni*, Semarang, xi.1909.

2 and 3. *P. stantoni*, Semarang, ii.1910.

4. *S.* (*Parrotomyia*) *mangana* or ally, Semarang, ii.1910. The arc bearing the cibarial teeth is nodular.

5. *S.* sp., probably *balica*, no locality or date recorded. Cibarium figured by Patton & Hindle (1928 : 542) as co-type. This and number 6 were accepted as *perturbans* by Sinton (1928*c* : 320).

6. *S.* sp., possibly near *balica*, ♂, no locality or date recorded. Terminalia figured by Patton & Hindle (1928 : 544) as co-type, name in legend wrong. Aedeagus pointed, paramere hooked, style with all spines terminal.

7. *S.* (*Neophlebotomus*) *balica*, Djakarta, xi.1908, labelled 'Patton, vis.' Wing length 1·97 mm.

8 and 9. *S. balica*, Semarang, i.1910. Wing length 1·97 and 1·98 mm.

10 and 11. *S. balica*, Semarang, ii.1910. Wing lengths 1·94 and 1·98 mm. Average length for numbers 7–11 is 1·97 (1·97–1·98) mm.

12. *S.* (*Neophlebotomus*) Djakarta sp., Djakarta, xi.1908, labelled 'Patton vis. . . . *P perturbans* det. de Meijere', evidently by Patton. Antenna 4–16 and abdomen missing. Wing length 1·68 mm.

13 and 14 (others presumably existed but were not mentioned by describer). *S. perturbans*, Djakarta, November and Semarang, June, described by de Meijere (1909). His mention of colour differences between Djakarta and Semarang specimens foreshadowed what we now know, that he was dealing with at least three species. His measurements for wing length suggested that *perturbans* was a small species and were used by Sinton (1924*d* : 1016) to differentiate provisionally an Indian sandfly, *sylvestris*, from it. He reinforced this view (1928*c* : 320) on the strength of drawings of specimens 5 and 6 by Patton and Hindle. Despite de Meijere's evidently careful drawing of the wing, his lengths prove unreliable, even if adjusted to show the length seen in the figure. This adjusted length is about 0·86 of the wing lengths as measured in the present paper.

No original type-labels now exist, and Quate's remarks (1967, published several years after inspection of the specimens) are not clear. The specimen chosen by him as lectotype, mounted in Euparal, and here numbered 13, retains the label 'Patton vis.' and is presumed to be one of two labelled by de Meijere as 'type'. Apart from this, neither of specimens 13 and 14 retains an original label. Quate's paper merely gives the locality as Java and the month as probably November. His small-scale drawing of the cibarium (perhaps made before the specimen had cleared) differs from the appearance of Fig. 169 which, with other characters, shows that the lectotype is the same taxon as that known for many years as *S. sylvestris*. The wing length is 2·25 mm.

Specimen 14 (wing length 1·99 mm) was labelled as paratype by Quate but not mentioned in his paper, and it is stated to come from Java and has no head. It is here treated as the paralectotype.

15 and 16. *S. perturbans*, Semarang, vii.1909. Depository, if any, unknown. These were treated by Nitzulescu (1930) as being found among co-types and described as *P. demeijerei*.

17 and 18. *S. perturbans*, Semarang, ii, iii.1910. Wing lengths 2·23 and 2·26 mm. Average length for numbers 13, 14, 17 and 18 is 2·18 (1·99–2·26) mm.

The West Malaysian *whartoni* is recognized as a synonym after inspection of *perturbans* from Java and India.

Material examined.

India: Sukna, 4 ♀. **Java:** Djakarta and Semarang, 4 ♀. **West Malaysia:** Gunong Besout Forest Reserve, 1974 (*A. B. Knudsen & colleagues*), 14 ♀, 24 ♂; Tanjong Rabok, x, xi.1969, 3 ♀; Ulu Langat Forest Reserve, 25.vii.1968, 1 ♀, 2 ♂ (*A. Rudnick*).

DISTRIBUTION. **Bangladesh:** Sylhet (Sinton, 1932*a* : 71). **Burma:** Rangoon (Sinton, 1928*c* : 320; 1932*a* : 71). **Cambodia:** Phnom Penh (Parrot & Clastrier, 1952 : 153). **India:** Jorhat (Sinton, 1924*d* : 1027); Doloi Valley, Sukna (Sinton, 1928*c* : 200). **Java:** Djakarta, Semarang (de Meijere, 1909 : 201; Nitzulescu, 1930 : 541). **Laos:** Vientiane (Quate, 1962*b* : 265). **Vietnam (North):** Bim Son, Cho Ganh, Dong Giao, Le Mi (Raynal, 1935*b* : 261); Bui Huy Tin, Phu Oc (Raynal, 1936*a* : 362). **West Malaysia:** Gunong Besout area (as above); Lubok Paku (Lewis, 1957 : 167); Gua 'Che Yatim (Quate & Fairchild, 1961 : 211); Tanjong Rabok (x, xi.1969, 3 ♀), Ulu Langat Forest Reserve (25.vii.1968, 1 ♀, 2 ♂) (*A. Rudnick*).

S. perturbans (=*sylvestris*) was taken by Sinton in the Darjeeling district of India, where it seemed to be associated with foothill jungle and Raynal (1936*a* : 361) noted that it occurred at quite a low altitude in India and Indo-China.

Sergentomyia (*Neophlebotomus*) *purii* (Sinton)

(Figs 178, 179, Map 10)

Phlebotomus purii Sinton, 1931*d* : 1203; 1931*e* : 110; 1932*a* : 60; 1933*c* : 421. LECTOTYPE ♀, here designated [examined]. INDIA: Sukna, viii.1928 (*I. M. Puri*), labelled 'type ♀',
Phlebotomus (*Prophlebotomus*) *purii* Sinton; Parrot, 1940 : 311; 1946 : 72.
Sergentomyia purii (Sinton); Theodor, 1948 : 11.
Sergentomyia (*Rondanomyia*) *purii* (Sinton); Theodor, 1958 : 2 [maxilla]; Lewis, 1973*a* : 251.

The long narrow pigment patch of the female is rather like that of *S. linearis* but the curved row of teeth and the spermatheca are quite different.

DISTRIBUTION. **India:** Marianbari, Sukna, Tindharia (Sinton, 1931*d* : 1203).

S. purii was first found in forest tree-holes at the base of the Himalaya in Darjeeling District (Sinton, 1932*a*).

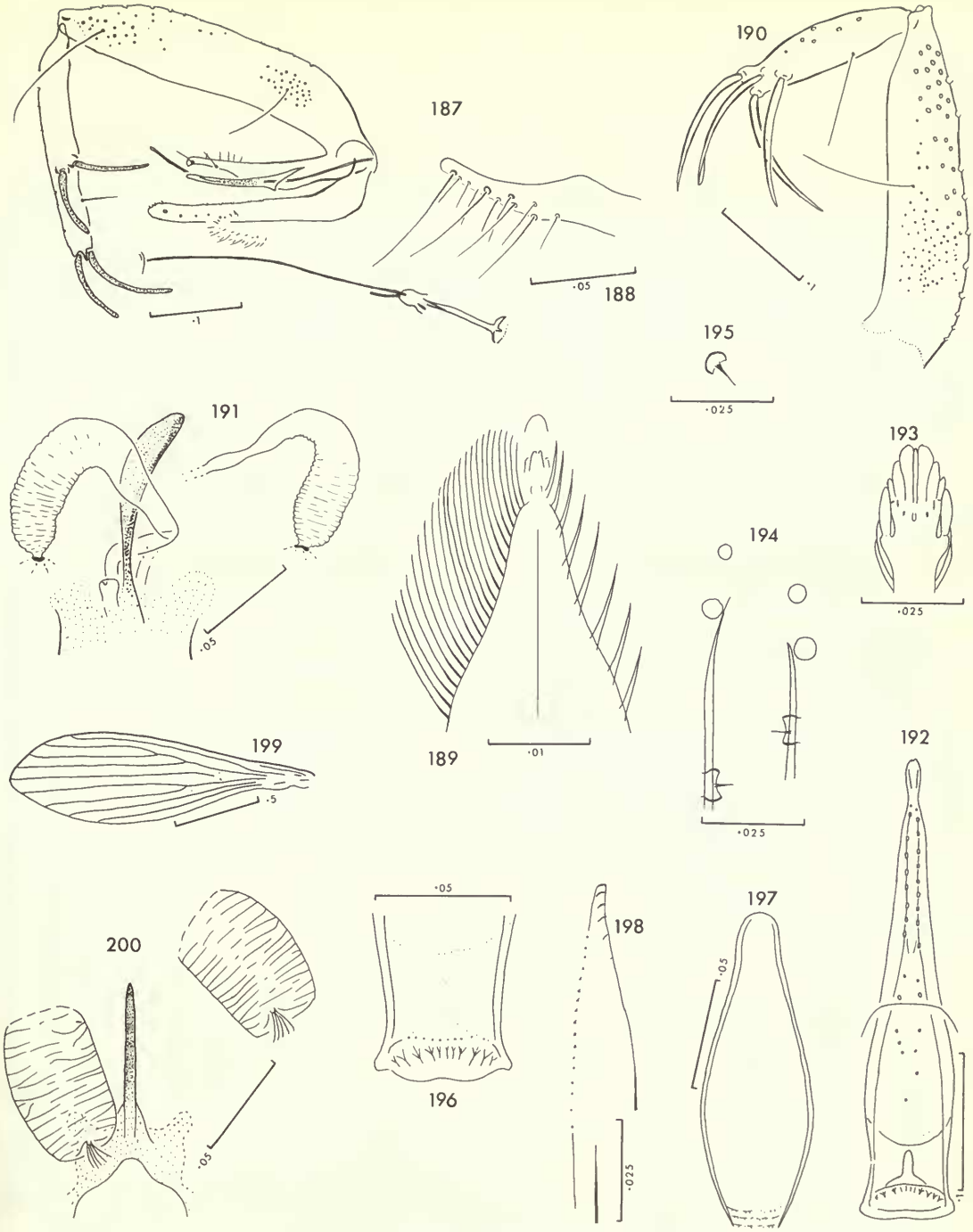
Sergentomyia (*Neophlebotomus*) *quatei* Lewis **sp. n.**

(Figs 180–188, Map 10)

The species is distinguished from all related ones by its cibarial armature, which slightly resembles that of *S. silvatica*, but *S. quatei* differs in having no pigment patch and a greater antenna 3/labrum figure. The armature of *S. quatei* is rather like that of the Australasian *S. brachycornuta* (Fairchild) which has a pigment patch and a shorter antenna 3.

♀. Eye 0·71 length of head. Head and most of labium dark. Labrum 0·21 (0·21–0·23) mm long, 0·10 (0·09–0·10) length of wing, apical sensilla normal, subapicals vestigial, adorals large and some of them accompanied by posteriorly converging lines. Cibarium with two middle teeth set backward, and about five small ones separate from them on each side, pigment patch absent, faint bulge present. Pharynx unarmed. Hypopharynx with vestigial serrations. Antenna 3 = 0·49 (0·46–0·52) mm long, 0·22 (0·22–0·24) length of wing, 0·86 (0·81–0·90) length of 4+5, 2·30 (2·21–2·36) length of labrum, ascoids delicate and difficult to see against brown antenna, two with short blunt spurs seen on segment 3, and one each on 3–10 and 12, many rather similar colourless hairs present, ascoid on 4 about 0·24 length of segment, no papilla on 5. Maxilla with nine low lateral teeth, and 32 small ventrals, dental depth 0·12 mm, palpal ratio about 10 : 14 : 23 : 16 : 41. Scutum, lower part of pleura, and coxae dark. Wing length 2·15 (2·15–2·23) mm long, 3·2 times width, R_2/R_{2+3} 1·30 (1·05–1·50), R_1 overlap/R_2 0·63 (0·40–0·68). Spermatheca with protruding knob and internal spicules which are just visible in freshly mounted specimens.

♂. Labrum 0·18 (0·17–0·19) mm long, 0·10 (0·09–0·11) length of wing. Cibarial teeth very variable, usually one to four large ones in centre and about six to ten small ones on each side, pigment patch absent. Pharynx unarmed. Antenna 3 very long, 0·58 (0·54–0·64) mm, 0·32 (0·28–0·35) length of wing, 0·78 (0·68–0·84) length of 4+5, 3·18 (2·88–3·48) length of labrum, one ascoid on segments 3–10 (others not seen). Wing length 1·82 (1·71–2·01) mm, 4 times width, R_2/R_{2+3} 1·16 (0·91–1·58), R_1 overlap/R_2 0·54 (0·45–0·64). Aedeagus tapering to blunt point. Paramere with very unequal hairs. Coxite with isolated sub-basal patch of about 31 hairs.



Figs 187–200 *Sergentomyia* species. 187, 188, *S. quatei*, ♂: (187) terminalia; (188) paramere from above. 189, 190, *S.* Sepilok sp., ♂: (189) tip of labrum from below, with upper hairs on right; (190) coxite and style. 191, *S. silvatica*, ♀ (Thailand), spermatheca. 192–200, *S. tambori*, ♀: (192) labrocibarium; (193) tip of labrum; (194) subapical and first adoral sensilla; (195) left tenth adoral sensillum; (196) cibarium; (197) pharynx; (198) maxilla; (199) wing; (200) spermathecae.

MATERIAL EXAMINED.
Holotype ♀, **Borneo** (Sabah): Sepilok, 7.ii.1972 (*D. J. Lewis*) (BMNH).
Paratypes. Same data, 7–15.ii.1972, 7 ♀, 27 ♂; 8 ♀ and 10 ♂ measured. (All in BMNH.)

Sergentomyia (*Neophlebotomus*) sp. (Rabok)

(Map 10)

The cibarial fore teeth are about four deep in a broad band, and the aedeagus is slender.

♂. Labrum 0·25 (0·24–0·26) mm long, 0·14 (0·13–0·15) length of wing. Cibarium with three pointed hind teeth and a few denticles on each side, and three rows of fore teeth, each with about ten. Pharynx with faint ridges. Antenna 3 = 0·41 (0·41–0·41) mm long, 0·23 (0·23–0·24) length of wing, 1·18 (1·17–1·19) length of 4+5, 1·66 (1·59–1·72) length of labrum, one ascoid on segments 3–15, that on 4 about 0·63 length of segment, with short blunt spur. Scutum and pleura very pale. Wing length 1·75 (1·71–1·79) mm, about 3·1 times width, R_2/R_{2+3} 1·39 (1·37–1·42), R_1 overlap/R_2 0·63 (0·59–0·66). Aedeagus with tip slightly turned up. Coxite with diffuse patch of about 30 thin hairs; style with seta and two of spines at about 0·6.

In the absence of females this species is left without a formal name.

MATERIAL EXAMINED.
West Malaysia: Tanjong Rabok, 27.xii.1968 (*A. Rudnick*), 2 ♀.

Sergentomyia (*Neophlebotomus*) sp. (Sepilok)

(Figs 189, 190, Map 10)

The coxite brush has over 52 hairs, more than in *S. hitchensi*, and the seta on the style is at 0.4.

♂. Rather dark, antennae with contrasting pale joints. Labrum 0·18 (0·17–0·20) mm long, 0·08 (0·08–0·09) length of wing, with stout upper brush-hairs. Cibarium with about six hind teeth and about six fore teeth, each in a row. Antenna 3 = 0·53 (0·48–0·60) mm long, 0·24 (0·23–0·26) length of wing, 1·22 (1·08–1·29) length of 4+5, 2·93 (2·79–3·10) length of labrum; ascoid on 4 = 0·2 length of segment. Palpal segment 4 subequal to or slightly longer than 3. Wing length 2·21 (2·13–2·27) mm, 3·6 times width, R_2/R_{2+3} 1·77 (1·52–1·89), R_1 overlap/R_2 0·67 (0·54–0·79). Coxite with over 52 hairs in brush; style with seta at 0·4 and the two subterminal spines at about 0·85.

In the absence of a female the species is not formally named.

MATERIAL EXAMINED
Borneo (Sabah): Sepilok, 15, 16.ii.1972 (*D. J. Lewis*), 4 ♂.

Sergentomyia (*Neophlebotomus*) *silvatica* (Raynal & Gaschen)

(Fig. 131, Map 10)

Phlebotomus sylvaticus Raynal & Gaschen, 1935*d* : 592 [♂ in fig. 4 not this sp. according to Quate, 1926*b* : 264]. Syntypes 3 ♀, 2 ♂, VIETNAM (NORTH) (depository unknown) [not examined].
Phlebotomus silvaticus Raynal & Gaschen; Anonymous, 1935 : 779 [justified emendation (ICZN Article 32(B))]; Raynal, 1935*b* : 265.
Phlebotomus (*Prophlebotomus*) *silvaticus* Raynal & Gaschen; Parrot, 1940 : 312; 1946 : 71; Parrot & Clastrier, 1952 : 162 [a ♂].
Sergentomyia silvatica (Raynal & Gaschen); Theodor, 1948 : 112.
Phlebotomus (*Sergentomyia*) *silvaticus* Raynal & Gaschen; Lewis, 1957 : 167 [a ♂].
Phlebotomus (*Sergentomyia*) *sylvaticus* Raynal & Gaschen; Quate, 1962*b* : 262 [description and fig. of antenna 3 different, pigment patch of ♂ variable].
Sergentomyia (*Rondanomyia*) *sylvatica* (Raynal & Gaschen); Lewis, 1973*a* : 251.

The cibarium of the female has about four to six teeth in the centre and a patch of eight to ten smaller ones on each side.

♀ (from Thailand). Labrum 0·22 (0·21–0·22) mm long, 0·09 (0·09–0·09) length of wing, adoral sensilla much as in *S. hamidi* and *S. quatei*. Cibarium with two main teeth and no visible pigment patch. Hypopharynx with low undulations. Antenna 3 = 0·40 (0·39–0·41) mm long, 0·17 (0·16–0·17) length of wing, 0·95 (0·89–1·02) length of 4+5, 1·86 (1·79–1·94) length of labrum. Maxilla with nine lateral and 29 ventral teeth, dental depth 0·10 mm. Wing length 2·38 (2·35–2·41) mm, R_2/R_{2+3} 0·73 (0·53–0·92), R_1 overlap/R_2 0·52 (0·47–0·57).

MATERIAL EXAMINED.
Thailand: Ban Bon Dan, 12.xii.1975 (*D. J. Gould*), 2 ♀.

COMMENTS. The Thailand females appear to be this species despite certain differences from Raynal's and Quate's descriptions. *S. hamidi* and *S. quatei* have a rather similar labrum and cibarial armature but differ in the spermathecal and other features.

Quate disregards the authenticity of Raynal's male because it has a cibarial armature like that of the female. The matter should not be regarded as settled because the sexes of the related *S. quatei* are very similar in this respect.

DISTRIBUTION. **Cambodia:** Phnom Penh (Parrot & Clastrier, 1952 : 155). **Laos:** Vientiane (Quate, 1962*b* : 264). **Thailand:** Ban Bon Dan (as above). **Vietnam (North):** Dong Giao, Nao Phu, Phu Oc (Raynal, 1935*b* : 269). **West Malaysia:** Rantau Panjang (? Lewis, 1957 : 67).

Sergentomyia (*Neophlebotomus*) *tambori* Lewis & Jeffery **sp. n.**

(Figs 192–203, Map 10)

The cibarium of the female has about 11 hind teeth (fewer than in *S. iyengari*), one irregular row of fore teeth, and a broad anterior projection on the pigment patch.

S. tambori, like *S. iyengari*, somewhat resembles the African *S. decipiens* and *S. dureni* but has a broad spermatheca.

♀. Labrum 0·17 (0·17–0·17) mm long, 0·10 (0·09–0·10) length of wing, with normal distal sensilla, subapicals with anterior pair small, adorals large with pegs pointing mesally, and cibarials less large with longer pegs. Cibarium with about 11 large pointed teeth, the two sublaterals on each side very wide, about 11 small fore teeth present in an irregular row, pigment patch pale brown, about 0·7 width of cibarium and having broad anterior projection with rounded tip. Pharynx with a few sparsely spiculate lines. Hypopharynx with about eight scarcely visible undulations on each side. Antenna 3 = 0·42 (0·40–0·44) mm long, 0·24 (0·23–0·25) length of wing, 1·24 (1·21–1·26) length of 4+5, 2·46 (2·42–2·50) length of short labrum, two ascoids on segments 3–15, that on 4 = 0·4 length of segment, no papilla on 5. Mandibles pointed. Maxilla with four low lateral teeth, 16 distinct ventrals, and a dental depth of 0·06 mm, palp with segment 1 small, ratio 10 : 27 : 53 : 56 : 89. Scutum pale brown and pleura pale. Wing length 1·77 mm, 3·2 times width, R_2 (very long)/R_{2+3} 3·31 (3·05–3·55), R_1 overlap/R_2 0·79 (0·76–0·81). Spermatheca broad and oblong, striated, with small knob in shallow pit, and faint ducts.

♂. Head missing. Scutum pale reddish brown and pleura mainly pale. Wing length 1·59 mm, 3·8 times width, R_2/R_{2+3} 1·00, R_1 overlap/R_2 0·71. Genital filament about 4·1 times length of pump which has large barrel. Aedeagus nearly parallel sided, mainly dark, with round tip. Paramere with pointed tip which scarcely turns downward. Coxite with no differentiated brush. Style: dorso-mesad spine thick; dorso-lateral spine thin; ventro-mesad spine (the only non-terminal one) rather thin and somewhat mesad; ventro-lateral spine thick; seta at 0·65.

MATERIAL EXAMINED.
Holotype ♀, **West Malaysia:** Gunong Besout Forest Reserve, 3.v.1974 (*K. A. Tambor*) (BMNH).
Paratypes. Same data as holotype, 3.v.1974, 1 ♂; 5.ii.1974 (*J. Jeffery & colleagues*), 1 ♀. (All in BMNH.)

Sergentomyia (*Neophlebotomus*) *tonkinensis* (Raynal & Gaschen)

(Map 10)

Phlebotomus tonkinensis Raynal & Gaschen, 1935*h* : 742 [figs in 1935*g*]; Raynal, 1935*b* : 273 [figs].
Holotype ♀, VIETNAM (NORTH) (depository unknown) [not examined].
Phlebotomus (*Prophlebotomus*) *tonkinensis* Raynal & Gaschen; Parrot, 1940 : 312; 1946 : 71.

Sergentomyia tonkinensis (Raynal & Gaschen) Theodor, 1948 : 112.
Sergentomyia (*Rondanomyia*) *tonkinensis* (Raynal & Gaschen) Lewis, 1973*a* : 251.

This species has neither fore teeth nor pigment patch.

DISTRIBUTION. **Vietnam (North)** (rare): Phu Doan (Raynal, 1935*b* : 274; 1936*a* : 363).

Sergentomyia (*Neophlebotomus*) *traubi* (Lewis) **comb. n.**

(Map 10)

Phlebotomus traubi Lewis, 1957 : 169; Quate & Fairchild, 1961 : 216. Holotype ♀, WEST MALAYSIA (BMNH) [examined].

The female has fold-like cibarial teeth unlike those of other species. The species is placed in *Neophlebotomus* owing to the structure of the terminalia of the male.

♂. Labrum 0·18 mm long, 0·11 length of wing. Cibarium with 12 fold-like teeth, longer in the centre, and no pigment patch. Pharynx with a few faint ridges. Antenna 3 = 0·53 mm long, 0·33 length of wing, 2·94 length of labrum; ascoid on 4 = 0·15 length of segment; segment 5 and rest missing. Wing length 1·61 mm, R_2/R_{2+3} 0·75, R_1 overlap/R_2 0·35. Genital filament 3·0 length of pump. Aedeagus nearly parallel-sided, and tapering rather abruptly to a broadly rounded tip. Paramere slightly beaked. Coxite long and narrow, with hairs little differentiated except for four big ones in a row near tip. Style narrow with two spines at 0·67, a seta at 0·73 and two spines at tip.

MATERIAL EXAMINED.
West Malaysia: Bukit Ibam, 1.x.1961 (*L. W. Quate*), 1 ♂.

DISTRIBUTION. **West Malaysia:** Bukit Ibam (*L. W. Quate* via BPBM), commonest species, 41 ♀, 1 ♂; Teranggan (Quate & Fairchild, 1961); Ulu Gombak (Lewis, 1957). **Borneo** (Sabah): Kalabakan River (Quate & Fairchild, 1961).

Sergentomyia (*Neophlebotomus*) *zeylanica* (Annandale)

(Fig. 204, Map 10)

Phlebotomus zeylanicus Annandale, 1910*a* : 60; 1911*b* : 203; Brunetti, 1912 : 215; Sinton, 1924*e* : 1029 [sexes misassociated, ♀ valid species, described; ♂ was *P. argentipes*]; 1928*c* : 319; 1931*e* : 110; 1932*a* : 61; 1933*e* : 420; Theodor, 1938*a* : 261 [♀ ♂, ♂ differs from previous descriptions]; Mitra, 1953*b* : 162. Lectotype ♀, SRI LANKA (Zoological Survey of India), designated by Quate, 1962*c* : 158 [not examined].
Phlebotomus chalami Young & Chalam, 1927 : 849 [conditional name]. Syntypes ♀ ♂, INDIA (sent to former Central Research Institute, Kasauli) [not examined]. [Synonymized by Sinton, 1928*c* : 319.]
Phlebotomus (*Prophlebotomus*) *zeylanicus* Annandale; Parrot, 1946 : 70, 71.
Phlebotomus (*Sergentomyia*) *zeylanicus* Annandale; Quate, 1962*c* : 158, 160 [spermatheca].
Sergentomyia (*Rondanomyia*) *zeylanica* (Annandale); Lewis, 1973*a* : 251.

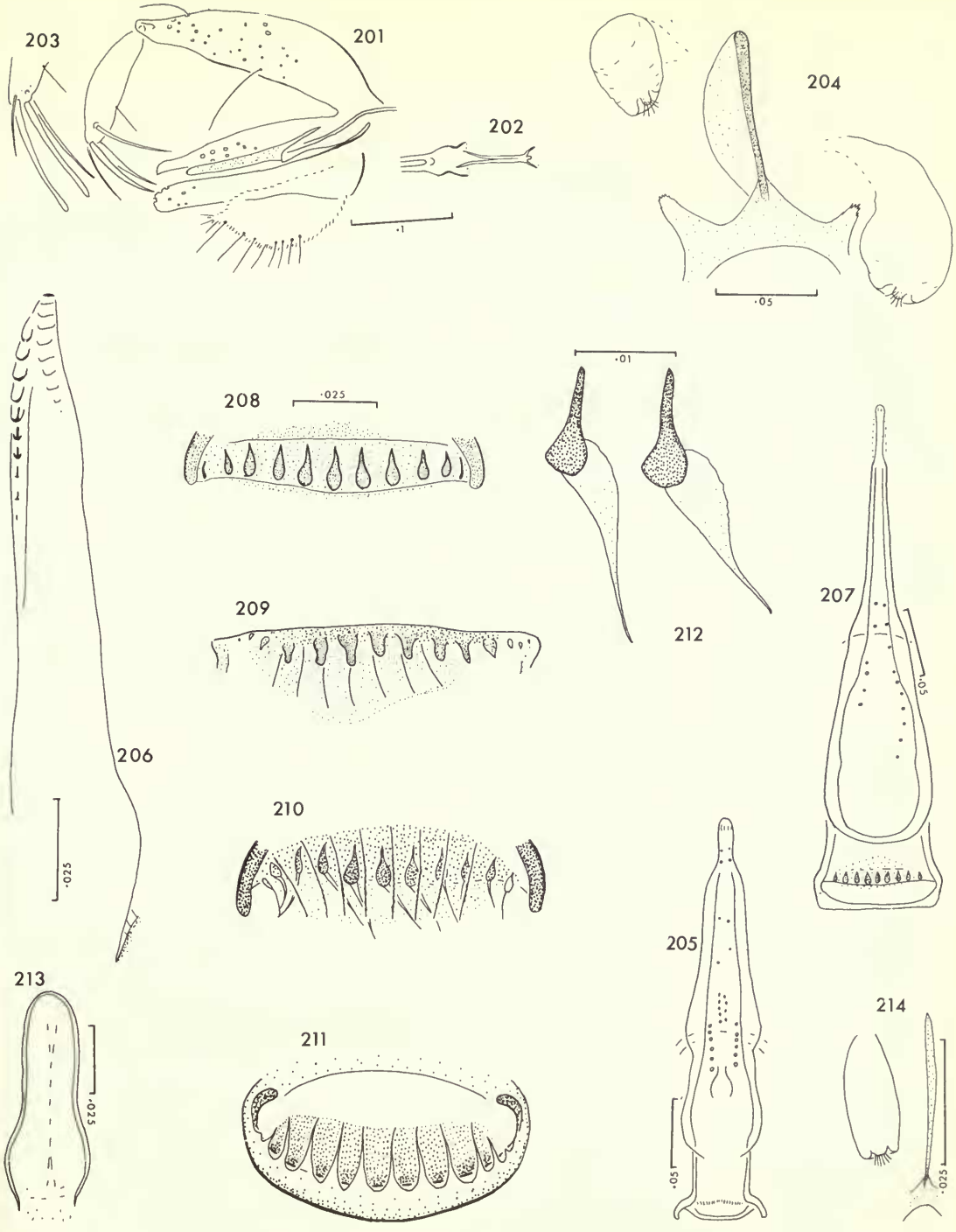
The female of *S. zeylanica* differs from *S. malayae* in having a shorter labrum.

♀ (*extra facts*). Labrum 0·31 mm long, 0·15 length of wing (1·20 mm). Antenna 3 = 0·31 mm long, 0·16 length of wing, 1·14 length of 4+5, 1·01 length of labrum. Maxilla with three lateral and 30 ventral teeth, dental depth 0·11 mm.

MATERIAL EXAMINED.
Sri Lanka: Peradeniya, 30.iv.1914, 1 ♀.

DISTRIBUTION. **India:** Kulathurpuzha (BMNH); Dehra Dun area, Naini Tal area (Rao *et al.*, 1973); Bombay, Gauhati (Sinton, 1928*c* : 319); Marianbari (Sinton, 1931*e* : 107); Darjeeling (Theodor, 1938 : 263). **Sri Lanka:** Peradeniya (Annandale, 1910*a* : 59, fig. 166, 25.viii.1910); Depanama, Kalgoda, Katuwawala, Maharagama (Theodor, 1938 : 262).

S. zeylanica appeared to occur in many widely separated parts of India and to be a wild species associated chiefly with jungle and moist warm conditions (Sinton, 1932*a* : 71).



Figs 201–214 *Sergentomyia* species. 201–203, *S. tambori*, ♂: (201, 202) terminalia; (203) left style in side-view. 204, *S. zeylanica*, ♀ (Sri Lanka), spermatheca. 205, 206, *S. bailyi*, ♀ (Andaman Islands): (205) labrocibarium; (206) maxilla. 207–214, *S. cheongi*, ♀: (207) labrocibarium; (208) teeth; (209) teeth and pigment patch in postero-ventral view; (210) teeth and pigment patch crushed; (211) teeth and pigment patch in thick section, anterior view; (212) crushed teeth; (213) pharynx; (214) spermatheca.

The *nicnic*-group

Sergentomyia nicnic group Theodor, 1948 : 102.

The minute cibarial teeth are a feature of this group in which Theodor placed *S. bailyi*, *S. kachekensis*, *S. nicnic* and one African species which may not belong to it.

Sergentomyia bailyi (Sinton)

(Figs 205, 206, Map 11)

Phlebotomus bailyi Sinton, 1931*b* : 821; 1932*a* : 60; Parrot, 1946 : 72. Syntypes ♀ ♂, INDIA (depository unknown) [not examined].

Phlebotomus bailyi var. *campester* Sinton, 1931*b* : 822; 1931*d* : 104; Raynal, 1935*a* : 369; 1935*b* : 277; Raynal & Gaschen, 1934*c* : 563; 1934*e* : 858; Theodor, 1938 : 268; Causey, 1938 : 487; Yao & Wu, 1940 : 782; 1941*b* : 77. [Synonymized by Quate, 1962*b* : 262.]

Phlebotomus (*Prophlebotomus*) *bailyi* var. *campester* Sinton; Parrot & Clastrier, 1952 : 155 [including abnormality].

Phlebotomus smithi Mitra & Roy, 1952*a* : 187 [♀]; Mitra, 1953*a* : 473 [♂]. Holotype ♀, INDIA (depository unknown) [not examined]. **Syn. n.**

Sergentomyia (*Sergentomyia*) *bailyi* (Sinton); Theodor, 1948 : 112; Lewis, 1967 : 38.

Phlebotomus (*Sergentomyia*) *bailyi* Sinton; Quate, 1962*b* : 260, 261, 262, 264.

In the female the cibarial cornua are large, the pigment patch is small or absent, and the very small teeth tend to be arranged in rows especially at the sides, the pharynx has spiculate ridges, and the spermatheca (Sinton, 1932*a* : 60) narrows at its apex.

The female, and probably the male, of *S. smithi* appear to be *S. bailyi*, and apparent differences to be caused by mounting methods and variation.

♀ (*extra facts*). Mandibular main teeth 2·0 μm wide. Maxillary ventral teeth large.

DISTRIBUTION. **Andaman Is.:** South Andaman, Chinya Tapu, 12.ii.1970 (*N. L. Kalra*), 2 ♀. **Cambodia:** Phnom Penh (Parrot & Clastrier, 1952 : 153). **China:** Aihsien, Kachek, Kan-en, Lingmen, Lingshui, Linko, Mencheong, Nodoa, Paoting, Wanning (Yao & Wu, 1940 : 797; 1941*b* : 77). **India:** Ajmer (Jaswant Singh, 1933); Badam Pahar, Itaunia, Patna, Vellore (BMNH); Aurangabad, Jalna, Patan (Farooq & Qutubuddin, 1945 : 85); Bundi area, Jaipur, Kota area, Sirohi area (Kaul *et al.*, 1973 : 532); Poona (Mitra & Roy, 1952*a*, *S. smithi*); Hyderabad (Qutubuddin, 1944 : 208); Madras (Rathnaswamy & Rama Krishna, 1954); Barhi, Bissem Cuttack, Chandigarh, Chhindwara, Dehra Dun, Hardwar, Hazaribagh, Itarsi, Kamptee, Karnal, Kasauli, Khandwa, Laharpur, Nagpur, Pachmarhi, Parasia, Pipariya, Roorkee, Saharanpur, Titilagarh (Sinton, 1931*b* : 821); Bhavnagar, Rajkot, Sanawar, Wadhwan (Sinton's notes); Baraga, Hosur, Jog-Sagar area, Kannur, Kumsi, Poona, Wai (*H. Trapido*). **Laos:** Vientiane (Quate, 1962*b* : 262). **Pakistan:** Dehra Ismail Khan, Jandola, Kohat-Hangu valley, Lahore, Larkana, Pano Aqil, Peshawar, Rawalpindi, Shikarpur, Tando Muhammad Khan, Tank, Taxla (Lewis, 1967 : 39). **Thailand:** Bangkok (Sinton, 1931*d* : 104); in train (Causey, 1938 : 487, 488); Pechaburi (Quate, 1962*b* : 262). **Vietnam (North):** Bim Son, Cho Ganh, Cua Rao, Dong Giao, Kep, Phu Qui, Vin Thui (Raynal, 1935*b* : 282). **Vietnam (South):** Duc Pho (Raynal, 1935*b* : 282).

In India Sinton (1931*b*) found that *S. bailyi* was widespread up to 1830 m, but much less numerous than *S. babu*, and that it was relatively more numerous in the hills. In Indo-China Raynal (1936*a* : 351, 357) found *S. bailyi* south of 20° north.

Sergentomyia displicata (Quate & Fairchild)

(Map 11)

Phlebotomus (*Sergentomyia*) *displicatus* Quate & Fairchild, 1961 : 212 [♂]. Holotype ♂, BORNEO (BPBM) [not examined].

The cibarium of the male has about 15 hind teeth and a double row of 20 fore teeth, and the area between them and the arch is dark. The male differs from that of *S. nicnic* in having no pigment patch and a longer antenna 3.

DISTRIBUTION. **Borneo** (Sabah): Kalabakan River (Quate & Fairchild, 1961 : 214).

Sergentomyia kachekensis (Yao & Wu)

(Map 11)

Phlebotomus kachekensis Yao & Wu, 1940 : 790 [♂]; 1941*b* : 78. Holotype ♂, CHINA (depository unknown) [not examined].
Sergentomyia kachekensis (Yao & Wu); Theodor, 1948 : 113.

This species, described from one male, was placed in this group by Theodor. It is left here, in the absence of more material, although the original drawing showing diamond-shaped teeth suggests that it may belong elsewhere.

DISTRIBUTION. **China:** Hainan Island (Yao & Wu, 1941*b* : 77); Kachek (Yao & Wu, 1940 : 790).

Sergentomyia nicnic (Banks)

(Map 11)

Phlebotomus nicnic Banks, 1919*a* : 163; Sinton, 1928*c* : 317; 1930*a* : 165; 1931*b* : 824; Manalang, 1930*a* : 169; Theodor, 1938 : 268. Holotype ♂, PHILIPPINES (destroyed, according to Quate & Rosario) [not examined].
Phlebotomus (*Prophlebotomus*) *nicnic* Banks; Parrot, 1940 : 311; 1946 : 72.
Phlebotomus (*Sergentomyia*) *nicnic* Banks; Quate & Fairchild, 1961 : 214; Quate & Rosario, 1962 : 794.

In this small species the female has a weak armature of many small teeth, big cornua, prominent hypopharyngeal teeth, and spermathecae narrow proximally, and the paramere of the male has an unusually large tip.

DISTRIBUTION. **Nusa Tenggara:** Kabaru, Pedang Bay, Sumbawa (Lewis & Dyce, 1976 : 212). **Philippines:** Los Baños (Banks, 1919*a* : 167; Sinton, 1930*a* : 165); Nueva Viscaya (*M. D. Delfinado & D. E. Hardy*, via BPBM); Novaliches (Manalang, 1930*a* : 169); Pili (Quate, 1965 : 28); Bay, Jose del Monte (Quate & Rosario, 1962 : 796).

UNGROUPED

It is difficult to classify this miscellaneous assemblage, but it is convenient to divide the females, as in the key, into those with thick cibarial teeth, those with certain outstanding features, and those with a rather simple row of equal teeth. A few species could, perhaps, be offshoots of *Parrotomyia* or *Neophlebotomus* which have lost their subgeneric characters.

Sergentomyia angustipennis (de Meijere) **comb. n.**

(Map 11)

Phlebotomus angustipennis de Meijere, 1909 : 202; Annandale, 1910*b* : 52; 1911*a* : 62; Sinton, 1928*c* : 322; Nitzulescu, 1930 : 545. Holotype, sex not given, JAVA (depository unknown [not examined].

The short description of *S. angustipennis*, meaning short-winged, refers to a few external characters and is accompanied by a figure of the wing, the narrowness of which suggests that the species belongs to the genus *Sergentomyia*. An adequate description could be prepared if *S. angustipennis* could be recognized during a survey of the local species.

DISTRIBUTION. **Java:** Semarang.

Sergentomyia anodontis (Quate & Fairchild)

(Map 11)

Phlebotomus (*Sergentomyia*) *anodontis* Quate & Fairchild, 1961 : 220; Lewis & Wharton, 1963 : 120. Holotype ♂, WEST MALAYSIA (BPBM) [not examined].

In this small species with a brown scutum and pale pleuron the cibarium of the female has spine-like projections from a fold in the membrane above the sclerotized part, and a medium projection over which is an inverted V-shaped bar, and tergite 8 has a lateral patch of hairs. The spermatheca is long and tubular with a thick knob and is not differentiated from its duct which joins a common duct. The style of the male is slender with a seta at 0·7, one spine at 0·75, one subterminal and one terminal. *S. anodontis* is closely related to the Chinese *S. koloshanensis* (Yao & Wu).

In a female from Betis the hypopharynx has definite low teeth, and the maxilla has nine lateral teeth of moderate size, 29 strong ventrals, and a dental depth of 0·09 mm.

DISTRIBUTION. **West Malaysia:** Betis (Lewis, 1957 : 121); Batu Caves (Quate & Fairchild, 1961 : 220).

Sergentomyia cheongi Lewis & Jeffery **sp. n.**

(Figs 207–214, Map 11)

The female differs from most species in its pear-shaped cibarial teeth, and from *S. losarcus* in having a very short inter-arcal area, a smaller antenna 3/labrum figure, palpal segment 3 shorter than 4, and Newstead's sensilla concentrated.

♀. Labrum 0·19 (0·18–0·20) mm long, 0·09 (0·10–0·11) length of wing, narrow, with very small subapical sensilla, few adorals and small cibarials. Cibarium with inter-arcal thick posterior area supporting nine large pear-shaped teeth with long dorsal points which are invisible from below; pigment patch brown with about eight longitudinal lines. Pharynx with narrow unarmed hind end. Hypopharynx with low rounded teeth. Antenna 3 = 0·31 (0·30–0·34) mm long, 0·16 (0·16–0·17) length of wing, 1·27 (1·23–1·33) length of 4+5, 1·60 (1·50–1·72) length of labrum, two ascoids on segments 3–15, that on 4 about 0·46 length of segment, no papilla on 5. Mandible with wide-angled tip. Maxilla with 12 broad lateral teeth and 25 ventrals, dental depth 0·07 mm; palpal ratio about 10 : 21 : 33 : 48 : 98; sensilla concentrated on basal quarter of 3. Scutum, pleuron and much of body reddish brown. Wing length 1·90 (1·79–1·99) mm, 3·5 times width, R_2/R_{2+3} 1·34 (0·84–2·09; minimum exceptionally low), R_1 overlap/R_2 0·60 (0·52–0·71). Spermatheca oblong with delicate duct.

The harrow-like cibarial armature is seen in this species, *S. perturbans*, and a few others.

MATERIAL EXAMINED.
Holotype ♀, **West Malaysia:** Gunong Besout Forest Reserve, 4.ii.1974 (*J. Jeffery*) (BMNH).
Paratypes. Same data, 9 ♀ (BMNH). Ten ♀ measured.
Non-paratypic material. **West Malaysia:** Bukit Ibam (*L. W. Quate* via BPBM), 1 ♀.

Sergentomyia dapsilidentes (Quate)

(Map 11)

Phlebotomus (*Sergentomyia*) *dapsilidentes* Quate, 1965 : 26. Holotype ♀, PHILIPPINES (BPBM) [not examined].

In the female of this pale species there are 30 cibarial hind teeth in a compact row and about 80 fore teeth in five or six rows, and an unusually long palpal segment 4.

DISTRIBUTION. **Philippines:** Manucan, Zamboanga del Norte (Quate, 1965 : 28).

Sergentomyia delfinadoae (Quate)

(Map 11)

Phlebotomus (*Sergentomyia*) *delfinadoae* Quate, 1965 : 30. Holotype ♀, PHILIPPINES (BPBM) [not examined].

The female of this large species has a brownish scutum and about 10–14 cibarial teeth like barbed hooks, a rectangular pigment patch and a long antenna 3. The male has six to ten barbed teeth. The species somewhat resembles *S. exastis*.

♀ (*extra facts*). Labrum with the foremost adoral sensilla large, in three diagonal pairs. Hypopharynx smooth. Maxilla with eight moderately broad lateral teeth and 17 distinct ventrals, dental depth 0·10 mm.

DISTRIBUTION. **Philippines:** Cuernos de Negros (Quate, 1965 : 30).

Sergentomyia dentacea (Quate)

(Map 11)

Phlebotomus (*Sergentomyia*) *dentaceus* Quate, 1965 : 26. Holotype ♀, PHILIPPINES (BPBM) [not examined].

In the female of this large species the cibarial teeth are very long and the pharyngeal teeth are markedly posterior.

DISTRIBUTION. **Philippines:** Los Arcos (Quate, 1965 : 26).

Sergentomyia exastis (Quate)

(Map 11)

Phlebotomus (*Sergentomyia*) *exastis* Quate, 1965 : 33. Holotype ♀, PHILIPPINES (BPBM) [not examined].

This is a large species and the female has no pigment patch and 14 inwardly sloping cibarial teeth rather like those of the related *S. delfinadoae* and the African *S. schwetzi*.

DISTRIBUTION. **Philippines:** San Francisco (Quate, 1965 : 33).

Sergentomyia fanglianensis (Leng)

(Map 11)

Phlebotomus fanglianensis Leng, 1964 : 118, 127. Syntypes ♀ ♂, CHINA (Lianming University, Shenyang) [not examined].

In the female the cibarium has no pigment patch and many small triangular teeth tending to form three rows medially, the pharynx has finely spiculate ridges, and the smooth carrot-shaped spermatheca has a deep pit. In the male the cibarial teeth tend to form three rows, R_2/R_{2+3} is over 1·5 (1·63–1·80), and the style has a seta, two subapical spines on a tubercle and two apical spines.

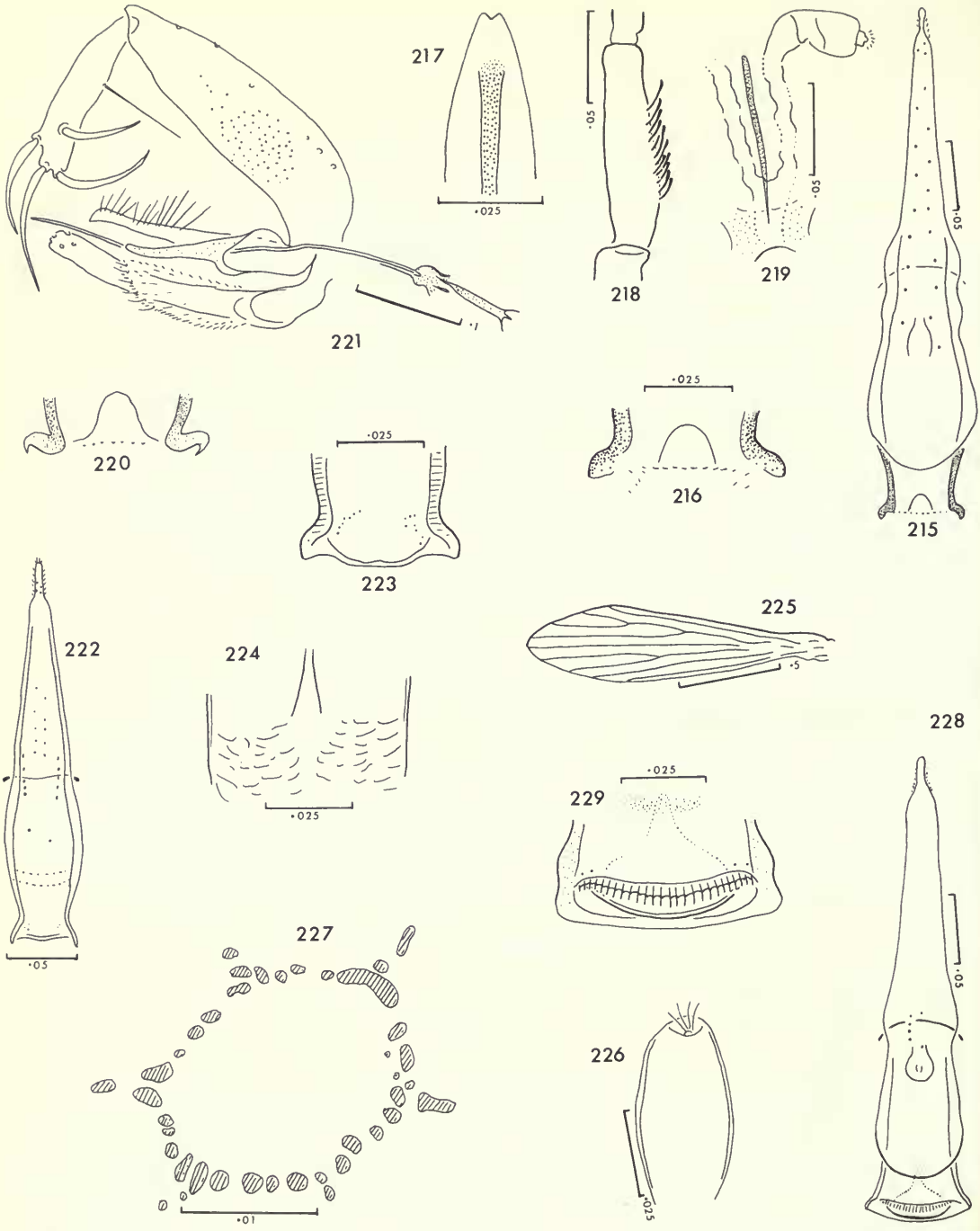
DISTRIBUTION. **China:** Fanglian (Leng, 1964 : 127).

Sergentomyia hassani Lewis **sp. n.**

(Figs 215–221, Map 11)

The female is very like that of *S. hitchensi* but has a long row of palpal sensilla.

♀. Eye 0·62 length of head. Labrum 0·19 (0·18–0·19) mm long, 0·08 (0·07–0·08) length of wing, with adoral sensilla well developed. Cibarium with narrow hind end and deep notch (not seen in macerated flies) in dorsal wall, inter-arcal walls dark, and a nearly straight row of small separate teeth, which are blunt in ventral view and merge into spicules on cibario-pharyngeal membrane, and no pigment patch. Pharynx unarmed and rather soft with variable shape. Hypopharynx completely smooth. Antenna 3 = 0·39 (0·38–0·40) mm long, 0·16 (0·15–0·17) length of wing, 1·35 (1·31–1·36) length of 4+5, 2·13 (2·09–2·16) length of labrum, two ascoids on segments 3–15, that on 4 being slender and about 0·43 length of segment, no papilla on 5. Maxilla with nine narrow lateral teeth, 25 ventrals, and a dental depth of 0·09 mm; palpal ratio 10 : 12 : 26 : 27 : 63; sensilla scattered along most of length of 3. Scutum pale reddish brown, pleuron mainly pale. Wing 2·42 (2·32–2·53) mm long, 3·3 times width, R_2/R_{2+3} 2·38 (2·19–2·56), R_1 overlap/R_2 0·75 (0·74–0·76). Leg ratios: fore (0·96 mm), 50 : 80 : 46 ; hind (0·84 mm), 50 : 99 : 52; hind (0·94 mm), 50 : 104 : 71. Spermatheca subpyriform with delicate duct.



Figs 215–229 *Sergentomyia* species. 215–221, *S. hassani*: (215) ♀, labrocibarium; (216) ♀, cibarium; (217) ♀, tip of hypopharynx; (218) ♀, palpal segment 3; (219) ♀, spermatheca; (220) ♂, cibarium; (221) ♂, terminalia. 222–227, *S. jamesi*, ♀: (222) labrocibarium; (223) cibarium; (224) pharynx; (225) wing; (226) spermatheca; (227) pattern on contained egg. 228, 229, *S. knudseni*, ♀: (228) labrocibarium; (229) cibarium.

♂. Labrum 0·17 (0·15–0·19) mm long, 0·08 (0·07–0·09) length of wing. Cibarium with deep hind notch in soft tissue, about seven minute teeth, and no pigment patch. Pharynx unarmed. Antenna 3 = 0·46 (0·42–0·49) mm long, 0·22 (0·21–0·23) length of wing, 1·33 (1·28–1·38) length of 4+5, 2·78 (2·50–3·01) length of labrum, one ascoid on segment 3–15, that on 4 being 0·27 length of segment. Wing 2·12 (2·01–2·26) mm long, 3·5 times width, R_2/R_{2+3} 1·53 (1·07–1·88), R_1 overlap/R_2 0·69 (0·65–0·77). Aedeagus with narrow rounded tip, filament 3·3 times length of pump. Coxite with about 16 hairs in brush. Style with long stout seta at 0.25, one spine at 0·65, one at 0·75 and two at tip.

COMMENTS. *S. hassani*, like many sandflies, has a mixture of apparently plesiomorphic and apomorphic features. The former comprise a large delicate pale body, well-developed labral adoral sensilla, a cibarium with narrow hind end, small rather irregular teeth, and no pigment patch, extra ascoid-like structures on the antenna of the male, narrow maxillary lateral teeth, scattered Newstead's sensilla, a broad wing with long R_2 and a simple spermatheca.

This species is named after Mr Abu Hassan bin Omar of Kuala Lumpur who collected many sandflies.

MATERIAL EXAMINED.

Holotype ♀, **West Malaysia:** Ulu Langat Forest Reserve, 3.v.1966 (*A. Rudnick*) (BMNH).

Paratypes. Same data, 2 ♀, 8 ♂ (BMNH).

Non-paratypic material. **West Malaysia:** Kuala Tahan (*D. E. Hardy & T. C. Maa*, via BPBM); Bukit Ibam and Kuala Rompin area (*L. W. Quate*, via BPBM).

Sergentomyia heiseri (Manalang)

(Map 11)

Phlebotomus heiseri Manalang, 1930*e* : 299; Tonnoir, 1935 : 142; Raynal, 1935*a* : pls 10, 19; Quate & Rosario, 1962 : 796. Lectotype ♀, PHILIPPINES (on loan to BPBM), designated by Quate & Rosario [not examined].

The cibarium of the female has 12–18 long diamond-shaped hind teeth. It bears some resemblance to species of *Parrotomyia* but has different teeth, and shape and venation of the wing.

DISTRIBUTION. **Philippines:** Bigti, La Mesa, Novaliches, Tungkong Manga (Manalang, 1930*e*); Los Baños (Quate & Rosario, 1962 : 797).

Sergentomyia hitchensi (Manalang)

(Map 12)

Phlebotomus hitchensi Manalang, 1930*d* : 291; Tonnoir, 1935 : 142. Lectotype ♀, PHILIPPINES (on loan to BPBM), designated by Quate & Rosario, 1962 : 791 [not examined].

Phlebotomus (*Sergentomyia*) *hitchensi* Manalang; Quate & Rosario, 1962 : 791; Quate, 1965 : 30.

Sergentomyia (*Rondanomyia*) *hitchensi* (Manalang); Lewis, 1973 : 250.

The female has 12–15 triangular teeth in a regular row and no pigment patch. The species was placed in the *zeylanica* group by Theodor (1948) but is now removed owing to its uncharacteristic cibarial teeth and close affinity to *S. losarcus*.

DISTRIBUTION. **Philippines:** Tungkong Manga (Manalang, 1930*d* : 291); Eran area (Quate, 1965 : 30).

Sergentomyia imitor (Quate)

(Map 12)

Phlebotomus (*Sergentomyia*) imitor Quate, 1965 : 35. Holotype ♀, PHILIPPINES (BPBM) [not examined].

In this small pale species the cibarium of the female has 10–12 sharp spike-like teeth (a convergent resemblance to *S. clydei*) and 24–40 main fore teeth in two or three rows. The small well-defined coxite-brush of the male is at 0·3 and the style has two apical and two postmedial spines and a seta at 0·4–0·6. The terminalia are like those of *S. displicata* but the head is different.

DISTRIBUTION. **Philippines:** Los Arcos (Quate, 1965 : 37).

Sergentomyia jamesi Lewis **sp. n.**

(Figs 222–227, Map 12)

The female differs from all other *Sergentomyia* in having no cibarial teeth except a few lateral denticles.

♀. Labrum 0·16 mm long, 0·11 length of wing, with several posterior adoral sensilla and large lateral labro-cibarial sensilla. Cibarium with no teeth but a small group of denticles at each side; pigment patch absent and arch faint. Pharynx with faint ridges. Hypopharynx smooth. Antenna 3 = 0·12 mm long, 0·08 length of wing, 0·91 length of 4+5, 0·79 length of labrum, two ascoids on segments 3–15, that on 4 = 0·55 length of segment, no papilla on 5. Maxilla with 11 strong lateral teeth, 28 ventrals and a dental depth of 0·07; palp ratio 10 : 21 : 29 : 35 : 68; sensilla in compact bunch around 0·37. Scutum and pleuron brown, inter-precoxal lobes narrow, mesanepisternum without hairs. Wing length 1·48 mm, 4·1 times width, R_2/R_{2+3} 0·89, R_1 overlap/0·39. Leg ratios: fore (0·49 mm), 10 : 8·8 : 4·8; mid (0·54 mm), 10 : 10·5 : 5·5; hind (0·59 mm), 10 : 12 : 6·3. Spermatheca oblong.

Egg sculpture (seen in the single gravid ♀). Polygonal (as in some American species, Ward & Ready, 1975 : 128).

The species is named after Mr Samuel S. James, of the Arbovirus Research Laboratory field staff, West Malaysia.

MATERIAL EXAMINED.
Holotype ♀, **Thailand:** 'Trang Prov., Khaophappha Khaoc Hang, 200–300 m, 3.I.1944' (*G. A. Samuelson*, via BPBM). Mapped in Trang area.

Sergentomyia kelantani (Lewis & Wharton)

(Map 12)

Phlebotomus (*Sergentomyia*) *kelantani* Lewis & Wharton, 1963 : 123. Holotype ♀, WEST MALAYSIA (BMNH) [examined].

The female has nine large delicate cibarial teeth, with blackish pigment near their bases, antenna 3 = 0·19 mm long, and the spermatheca is a rigid thin-walled capsule bent double with a wide duct. The style of the male has two terminal and two subterminal spines.

DISTRIBUTION. **West Malaysia:** Betis (Lewis & Wharton, 1963 : 123).

Sergentomyia knudseni Lewis & Jeffery **sp. n.**

(Figs 228–237, Map 12)

A pale species with, in the female, regular cibarial teeth on a convex row, few or no fore teeth, a large bulge, maxilla without lateral teeth, and a broad wing with (in both sexes) short R_2 and R_1-overlap.

The females of several species have rather similar cibarial hind teeth. *S. bukidnonis* has fore teeth and more hind ones, and *S. franciscana* has fore teeth and a shorter labrum. The three Australian species, *S. cidaria* (Quate & Quate), *S. crypta* (Quate & Quate) and *S. vanella* (Quate & Quate) each have at least one distinct row of fore teeth.

♀. Labrum 0·19 (0·19–0·20) mm long, 0·12 (0·12–0·13) length of wing, with few adoral sensilla. Cibarium with arch far back, pigment patch broad but faint, and a wide hind bulge; 24–27 uniform pointed teeth present on slightly convex arch, and occasionally two fore teeth near each margin. Pharynx with marked brown subterminal bulge, narrow hind end and no teeth. Hypopharynx with low undulations. Antenna 3 = 0·23 (0·21–0·25) mm long, 0·14 (0·13–0·16) length of wing, 1·09 (1·04–1·17) length of 4+5, 1·17 (1·05–1·26) length of labrum, two ascoids on segments 3–15, that on 4 being slender, difficult to see, 0·86 length of segment and reaching the next one, no papilla on 5. Mandible pointed. Maxilla without lateral teeth but five vestigial specks, and 22 small ventrals, dental depth 0·07 mm; palpal ratio 10 : 18 : 31 : 35 : 64; sensilla based on basal third of 3. Scutum brownish, pleuron mainly pale. Wing length 1·59 (1·50–1·66)

mm, three times width, R_2/R_{2+3} 0·71 (0·54–0·90), R_1 overlap/R_2 0·36 (0·27–0·41). Spermatheca oblong and thin-walled with delicate duct joining short common duct.

♂. Labrum 0·16 mm long, 0·11 length of wing. Cibarium with about eight distinct separate pointed teeth on slightly convex arc, a strong bulge, and a pigment patch about two-thirds width of cibarium. Pharynx almost unarmed and very narrow posteriorly. Antenna 3 = 0·31 mm long, 0·21 length of wing, 1·22 length of 4+5, 1·89 length of labrum, one ascoid on segments 3–15 (last two missing), that on 4 being 0·75 length of segment and reaching its tip. Wing length 1·45 mm, 3·6 times width, R_2/R_{2+3} 0·52, R_1 overlap/R_2 0·15. Aedeagus with rounded tip. Coxite with nine narrow mesad hairs.

MATERIAL EXAMINED.

Holotype ♀, **West Malaysia:** Gunong Besout Forest Reserve, 24.ii.1974 (*J. Jeffery*) (BMNH).

Paratypes. Same data, 5.v-15.vi.1974, 13 ♀, 1 ♂; same data, 10.viii.1973 (*R. B. Tesh*), 1 ♀; Ulu Gombak, 20.viii.1960 (*Abu Hassan bin Omar*), 1 ♀. (All in BMNH.) Ten ♀ and 1 ♂ measured.

Sergentomyia lagunensis (Quate)

(Map 12)

Phlebotomus (*Sergentomyia*) *lagunensis* Quate, 1965 : 26. Holotype ♀, PHILIPPINES (BPBM) [not examined].

A large species with most of the pleuron brown and, in the female, 26 spike-like cibarial teeth and indistinct fore teeth.

DISTRIBUTION. **Philippines:** Los Baños (Quate, 1965 : 26).

Sergentomyia losarcus (Quate)

(Map 12)

Phlebotomus (*Sergentomyia*) *losarcus* Quate, 1965 : 30. Holotype ♀, PHILIPPINES (BPBM) [not examined].

In the female of this large dark species the slender cibarium has 8–10 stout teeth in a slightly convex row and no fore teeth or pigment patch, and a dark area between the teeth and the strong arch; the pharynx is unarmed and antenna 3 very long, and the spermatheca is subpyriform. On the style of the male is a seta at 0·4 or 0·5, two spines at 0·8, and two distal. The name is being treated as a noun.

The species is close to *S. hitchensi*, separable by the smaller number of differently shaped teeth and by distribution, and they may be forms of one species according to Quate.

DISTRIBUTION. **Philippines:** Los Arcos, San Francisco area (Quate, 1965 : 30).

Sergentomyia maai (Quate & Fairchild)

(Map 12)

Phlebotomus (*Sergentomyia*) *maai* Quate & Fairchild, 1961 : 218. Holotype ♀, BORNEO (BPBM) [not examined].

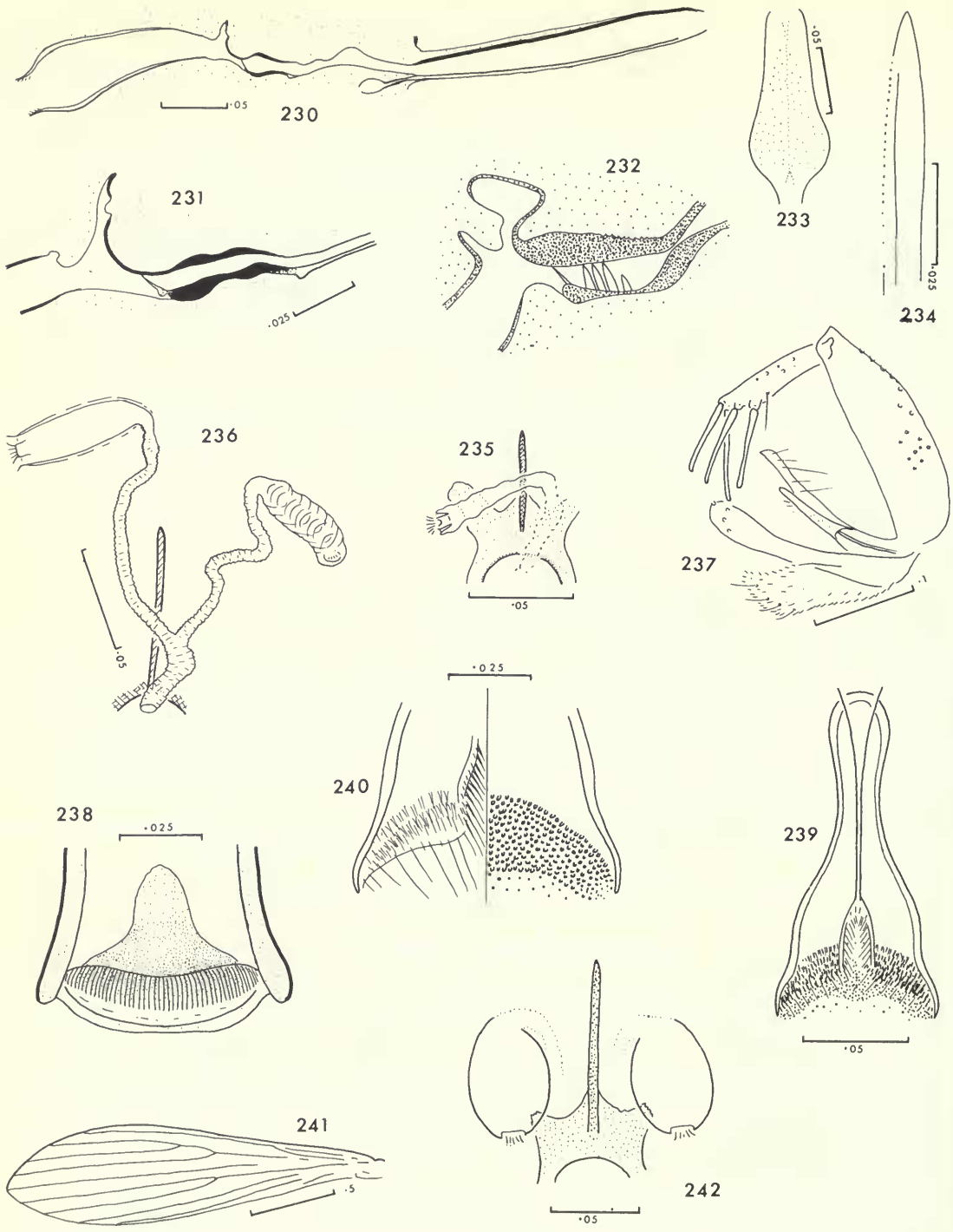
The cibarium of the female has 25 fish-hook-shaped teeth in an even comb and 14 fore teeth of which the centre ones are the larger, the pharynx is unarmed, the ascoids very short, and the spermatheca smooth and ovoid with a small head. On the style of the male two of the setae are subterminal.

DISTRIBUTION. **Borneo:** Tawau (Quate & Fairchild, 1961 : 218).

Sergentomyia mahadevani sp. n.

(Figs 238–242, Map 12)

In the female the cibarium has 50 long parallel teeth and a pigment patch with a broad fore end, the hind end of the pharynx is broad and indented, with numerous small teeth, antenna 3 and



Figs 230–242 *Sergentomyia* species. 230–237, *S. knudseni*: (230) ♀, sagittal section of fascicle and cibarium; (231) ♀, same of cibarium; (232) ♀, same of an American species (*Lutzomyia panamensis*) for comparison; (233) ♀, pharynx; (234) ♀, maxilla; (235, 236) ♀, spermathecae; (237) ♂, terminalia. 238–242, *S. mahadevani*, ♀: (238) cibarium; (239, 240) pharynx; (241) wing; (242) spermathecae.

R_1 are long, and the spermathecae are nearly spherical. The nature of the cibarium and pharynx, alone, suffice to distinguish this species from others.

♀. Labrum 0·20 mm long, 0·09 length of wing. Cibarium with about 50 long parallel teeth and a pigment patch with a broad fore end, hind bulge present. Pharynx with broad indented hind end and numerous closely packed small teeth. Hypopharynx with low rounded teeth. Antenna 3 = 0·44 mm long, 0·20 length of wing, 1·27 length of 4+5, 2·16 length of labrum, two ascoids on antenna 3–15, that on 4 being 0·4 length of segment amd having a vestigial spur 7·5 μm long, no papilla on 5. Maxilla with six not very wide lateral and 18 ventral teeth and a dental depth of 0·06 mm, palpal ratio 10 : 23 : 38 : 22 : 113, sensilla grouped near base. Scutum pale brown and pleuron pale. Wing length 2·24 mm, 3·5 times width, R_2/R_{2+3} 3·64, R_1 thick, R_1 overlap/R_2 0·74. Spermathecae nearly spherical with delicate ducts.

Material examined.
Holotype ♀, **Thailand:** Ban Bon Dan, 11.xii.1976 (*D. J. Gould*), light-trap with CO_2 in tropical evergreen and deciduous forest (BMNH).

Sergentomyia montana (Sinton)

(Map 12)

Phlebotomus minutus var. *montanus* Sinton, 1924*a* : 809, 812; 1927*c* : 949; 1927*d* : 26. Syntypes ♀ ♂, India and Pakistan (depository unknown except 1 ♀ in Indian Museum) [not examined].
Phlebotomus montanus (Sinton); Sinton, 1927*d* : 27 [cibarium]; 1927*e* : 31; 1928*c* : 316; 1929*b* : 174; 1932*a* : 61; 1933*e* : 422.
Sergentomyia montana (Sinton); Lewis, 1967 : 39; Artemiev, 1976*b* : 426.

The cibarium of the female has small lateral teeth in several rows, a pigment patch with broad forward process and pointed tail, a narrow pharynx with many teeth, and a spermatheca narrowing distally. The cibarium of the male has several rows of lateral teeth and a distinct narrow pigment patch.

Artemiev proposed to include *S. montana* in *Parrotomyia*, and to modify the diagnosis of the subgenus slightly.

Distribution. **India:** Bhowali (BMNH); Chamba area, Tehri area (Rao *et al.*, 1973); Kasauli, Naini Tal (Sinton, 1924*a* : 812). **Nepal:** Syabrudens (*L. W. Quate*, 2.xi.1965). **Pakistan:** Bahrein, Gilgit, Khaira Gali, Murree, Parkuta, Rawalpindi, Said Pur, Taxla (Lewis, 1967 : 40).

Sinton (1932*a*) found *S. montana* in the western Himalayan foothills at about 1830 m where (1928*c*) it was common and replaced the lowland *S. babu*.

Sergentomyia morini (Raynal & Gaschen)

(Map 12)

Phlebotomus morini Raynal & Gaschen, 1935*f* : 731 [♂]; Raynal, 1935*b* : 301; 1936*a* : 367. Syntypes 2 ♂, Vietnam (South) (depository unknown) [not examined].
Phlebotomus (*Prophlebotomus*) *morini* Raynal & Gaschen; Parrot, 1940 : 312; 1946 : 70.

The cibarium of the male has six or seven groups of small teeth, a few fore teeth, and no pigment patch. R_2/R_{2+3} is 0·73–0·76, and two spines on the style are subapical. The genital filaments are very long, 6·5–6·7 times as long as the pump.

Distribution. **Vietnam (South):** Duc Pho (Raynal, 1935*b* : 303; 1936*a* : 367).

Sergentomyia neras (Quate)

(Map 12)

Phlebotomus (*Sergentomyia*) *neras* Quate, 1965 : 28. Holotype ♀, Philippines (BPBM) [not examined].

This small species has antenna 3 very short and most of the scutum brown. The female has 14

inwardly sloping cibarial teeth in a compact row and two rows of 16 fore teeth, and a subpyriform spermatheca.

DISTRIBUTION. **Philippines:** Eran area (Quate, 1965 : 18).

Sergentomyia sp. (Okinawa)

(Map 12)

Sergentomyia sp. Lien, 1975 : 298.

In the one female known the cibarium has 70 teeth, the pharynx has about ten short spicules, R_2/R_{2+3} is 4·8 and the spermatheca is subovoid.

DISTRIBUTION. **Japan:** Ryukyu Retto, Okinawa.

Sergentomyia pachystoma (Quate & Fairchild)

(Figs 243–250, Map 12)

Phlebotomus (*Sergentomyia*) *pachystoma* Quate & Fairchild, 1961 : 215. Holotype ♀, BORNEO (BPBM) [not examined].

This pale species was named after a thick proboscis. In females from Borneo the cibarium has 22 teeth and 18 fore teeth, the inter-arcal area is sclerotized and wrinkled, the ascoids have a small spur and there appears to be only one ascoid on segments 11–15, and the spermatheca narrows before the tip and has a deep pit. The male is described here for the first time from West Malaysian specimens regarded as this species.

♀. Eye 0·44 length of head. Labrum 0·24 (0·23–0·26) mm long, 0·14 (0·13–0·15) length of wing. Cibarium with 24·2 (20–29) teeth and 19·0 (16–22) fore teeth, and a marked dorsal hind bulge, inter-arcal area with a wide brownish area merging into the brown arch but scarcely a trace of oblique lines, pigment patch rather broad and bearing imprints of fore and hind teeth. Pharynx at widest point about 0.81 width of cibarium. Hypopharynx with rounded teeth less than half as high as wide. Antenna 3 = 0·29 (0·27–0·30) mm long, 0·16 (0·15–0·18) length of wing, 0·13 (0·12–0·14) length of 4+5, 1·19 (1·07–1·25) length of labrum, ascoids with small spur, two ascoids on segments 3–15, distal ones delicate and sometimes difficult to see. Each mandible pointed, with wide teeth. Maxilla slender with small teeth, seven laterals and 36 ventrals, and a dental depth of 0·12 mm. Wing length 1·77 (1·70–1·88) mm, about 3·1 times length, R_2/R_{2+3} 1·52 (1·04–2·01), R_1 overlap/R_2 0·60 (0·52–0·71). Leg ratios, for comparison with original description; fore, 6 : 5·4; mid, 6 : 6·5 : 3·4. Spermatheca narrowing before tip, with deep pit and long knob.

♂. Labrum 0·25 (0·24–0·26) mm long, 0·14 (0·14–0·14) length of wing. Cibarium with about six long teeth and about 18 irregular fore teeth and no pigment patch. Pharynx with ridges and minute spicules. Antenna 3 = 0·42 (0·40–0·46) mm long, 0·24 (0·22–0·25) length of wing, 1·18 (1·16–1·25) length of 4+5, 1·69 (1·62–1·77) length of labrum, one ascoid with short spur on segments 3–15, that on 4 slender and about 0·6 length of segment. Wing length 1·79 (1·73–1·85) mm, 3·2 times width, R_2/R_{2+3} 1·33 (1·11–1·59), R_1 overlap/R_2 0·57 (0·50–0·65). Aedeagus tapering with rounded tip. Paramere beaked. Coxite with about 27 hairs in brush. Style with seta at 0·46, one spine at 0·42, one at 0·53 and two terminal.

COMMENTS. West Malaysian females differ from the Borneo description in several respects. In the former the cibarial teeth are more numerous on average, inter-arcal ridges are inapparent, the pigment patch (dissected out) proves to be a different shape, the pharynx is wider, the proboscis does not appear thick and includes a rather long labrum, and ascoid distribution (probably), wing length and leg ratios are different. Differences, however, could be due to infrasubspecific variation or to differences in mounting, and the two forms are treated as one species till more is known of the Borneo form.

MATERIAL EXAMINED.
West Malaysia: Gunong Besout Forest Reserve, 7.x.1973–15.vi.1974 (*J. Jeffery & K. A. Tambor*), 3 ♀; Tanjong Rabok, 12–28.xi.1969 (*A. Rudnick*), 7 ♀, 10 ♂.

DISTRIBUTION. **Borneo** (Sabah): Kalabakan River, Ranau (Quate & Fairchild, 1961 : 216). **West Malaysia:** Gunong Besout Forest Reserve, Tanjong Rabok (as above); Bukit Ibam (*L. W. Quate*, via BPBM).

Sergentomyia pooi (Yao & Wu)

(Map 12)

Phlebotomus pooi Yao & Wu, 1941*a* : 71; 1941*b* : 78 [♂]. Syntypes 4 ♂, CHINA (depository unknown) [not examined].

The cibarium of the male has no pigment patch, 23–29 hind teeth and 10–15 fore teeth. Its wing is about four times as long as wide, and R_2/R_{2+3} averages 0·76. Satisfactory identification will depend on finding the female.

DISTRIBUTION. **China:** Tienpao (Yao & Wu, 1941*a* : 71).

Sergentomyia reidi (Lewis)

(Figs 251–263, Map 13)

Phlebotomus (*Sergentomyia*) *reidi* Lewis, 1957 : 169 [♀]; Quate & Fairchild, 1961 : 220. Holotype ♀, WEST MALAYSIA (BMNH) [examined].

Behind the main cibarial teeth of the female is a remarkable group of teeth. Occasionally it may be hidden, if a head is tilted, so that the cibarium looks rather like that of *S. cheongi* which, however, has larger main teeth.

♀ (*extra facts*). Labrum about 0·19 mm long and 0·10 length of wing, with well-developed adoral sensilla. Cibarial main teeth arising from tough sclerotized band in front of hind margin of ventral plate; each tooth pear-like in ventral view but supporting long upward-pointing spine which is continuous with dorsal basal ridge of tooth; pigment patch with about 13 longitudinal lines. Hypopharynx with low blunt teeth. Mandible with rounded tip and long low teeth. Maxilla with ten broad lateral teeth, 32 ventrals, and a dental depth of 0·08 mm.

♂ (*first description*). Labrum 0·16 (0·16–0·17) mm, 0·11 (0·11–0·11) length of wing. Cibarium with seven or eight, slightly diverging and narrow, pointed hind teeth merging on each side into spicules of same shape; behind main teeth a patch of 8–16 narrow bent pointed teeth; all teeth under low power appearing spatulate owing to bending; pigment patch faint. Pharynx almost unarmed. Antenna 3 = 0·30 (0·29–0·32) mm long, 0·20 (0·19–0·22) length of wing, 1·20 (1·17–1·26) length of 4+5, 1·86 (1·76–1·98) length of labrum, one ascoid on 3–15, that on 4 about 0·39 length of segment, no papilla on 5. Wing length 1·49 (1·42–1·57) mm, 3·7 times width, R_2/R_{2+3} 1·62 (1·33–1·95), R_1 overlap/R_2 0·60 (0·51–0·69). Aedeagus narrow and tapering, filaments about 3·8 length of pump. Paramere hooked. Style with two of spines slightly subterminal, seta at about 0·76.

COMMENTS. The main cibarial teeth look rather like fore teeth because their long shafts point up and therefore do not appear behind the margin of the lower wall of the cibarium. The arrangement of the thick band at the bases of the teeth and of the pigment patch is like that seen in *S. perturbans*.

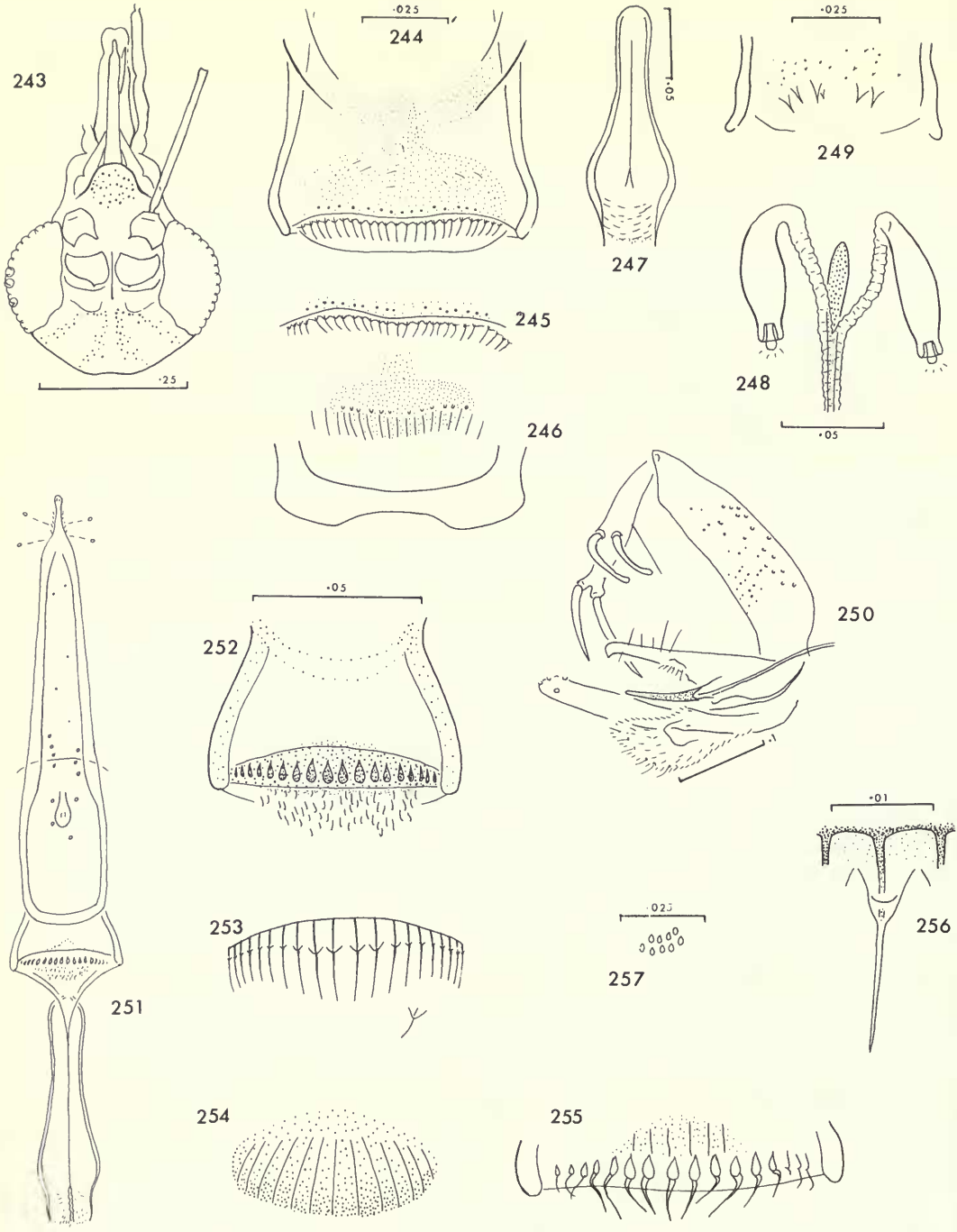
MATERIAL EXAMINED.
West Malaysia: Gunong Besout Forest Reserve, many; for above description, 24.iii.1974–15.vi.1975 (*J. Jeffery and colleagues*). 10 ♂ measured.

DISTRIBUTION. **West Malaysia:** Gunong Besout area (as above); Ulu Gombak (Lewis, 1957); Gua 'Che Yatim (Quate & Fairchild, 1961 : 220); Bukit Ibam, termite hills etc. on Fraser hill at 1360 m (*L. W. Quate*, via BPBM).

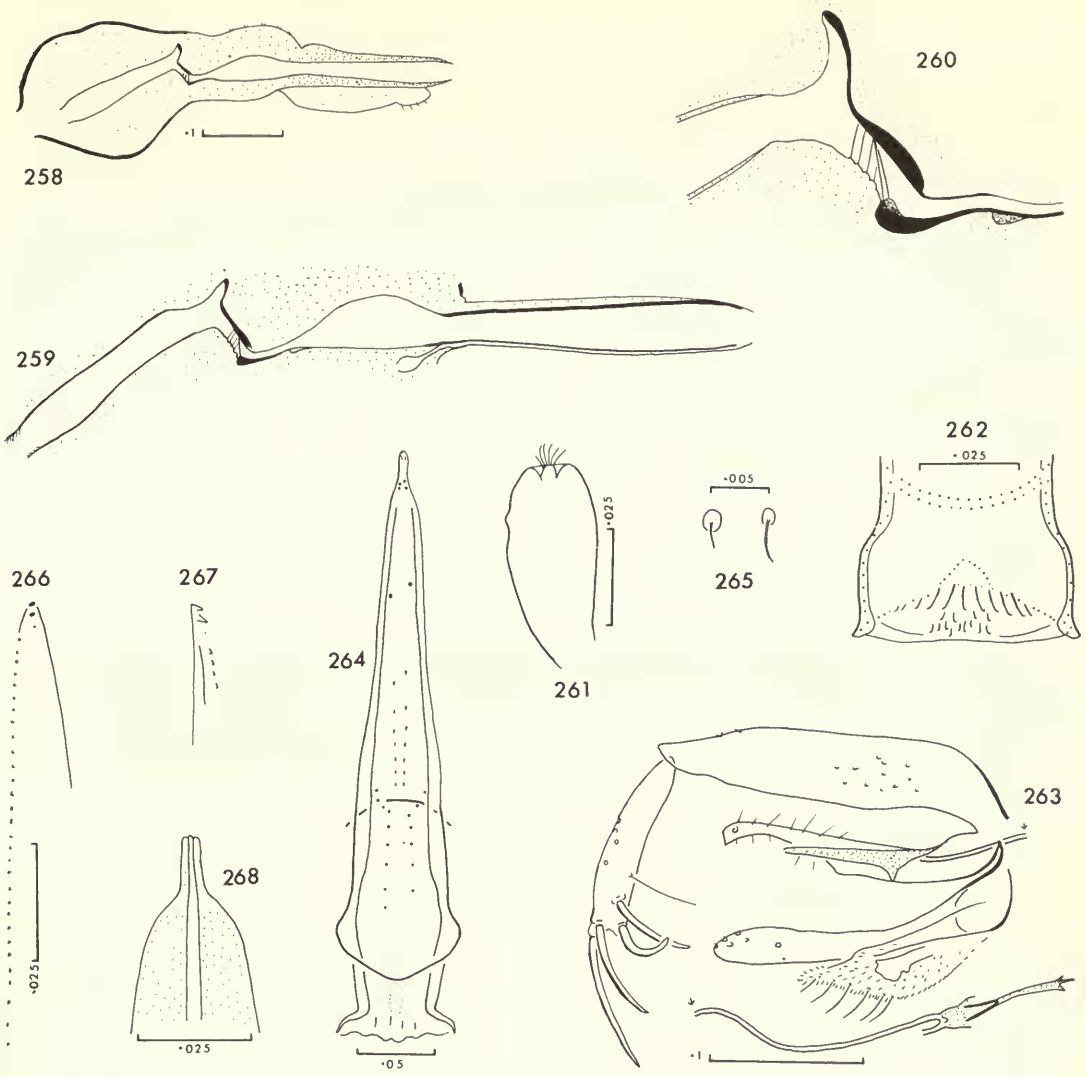
Sergentomyia tracheola (Quate)

(Map 13)

Phlebotomus (*Sergentomyia*) *tracheolus* Quate, 1965 : 24. Holotype ♀, PHILIPPINES (BPBM) [not examined].



Figs 243–257 *Sergentomyia* species. 243–250, *S. pachystoma*: (243) ♀, head; (244) ♀, cibarium; (245, 246) ♀, parts of cibarium crushed; (247) ♀, pharynx; (248) ♀, spermathecae; (249) ♂, cibarium; (250) ♂, terminalia. 251–257, *S. reidi*, ♀: (251) labrocibarium and pharynx; (252) cibarium; (253) main teeth and one small tooth crushed; (254) pigment patch of same fly removed; (255) main teeth and part of pigment patch of holotype partly flattened; (256) one tooth of Fig. 253; (257) small teeth in fresh Berlese's medium.



Figs 258–268 *Sergentomyia* species. 258–263, *S. reidi*: (258–260) ♀, sagittal section of head; (261) ♀, spermatheca; (262) ♂, cibarium; (263) ♂, terminalia. 264, 265, *S. christophersi*, ♀: (264) labrocibarium; (265) first and second adoral sensilla. 266, 267, *S. clydei*, ♀: maxilla, and its tip from another angle. 268, *S. eadithae*, ♀: tip of hypopharynx.

This is a large species with brown scutum. The cibarium of the female, with no pigment patch or fore teeth, has eight wedge-shaped teeth and a strong arch, and the pharynx has a compact group of teeth before the hind end. The spermatheca is pyriform.

DISTRIBUTION. **Philippines:** Katanglad Mount (Quate, 1965: 18).

Subgenus *SINTONIUS* Nitzulescu

Sergentomyia subgenus *Sintonius* Nitzulescu, 1931 : 273; Theodor, 1958 : 51; Perfil'ev, 1968 : 347. Type-species: *Phlebotomus hospitii* Sinton, 1924*g*, by subsequent designation by Lewis, 1973*a* : 232.

The segmented spermatheca, usually small, characterizes this subgenus which occurs largely in

the drier parts of the Old World. The Oriental species exist in the west. They may be divided into the *clydei* series, with 18 or fewer cibarial teeth, and the *hospitii* series, with 35 or more teeth and a narrow tip to the hypopharynx. Erect abdominal hairs are discussed under *S. clydei*.

Sergentomyia (*Sintonius*) *christophersi* (Sinton)

(Figs 264, 265, Map 13)

Phlebotonus christophersi Sinton, 1927*d* : 22, 24; 1927*e* : 31; 1927*f* : 33 [description]; 1932*a* : 60; 1932*b* : 571; 1932*c* : 579; 1933*e* : 420. Syntypes, PAKISTAN (depository unknown) [not examined].
Phlebotomus (*Prophlebotomus*) *christophersi* Sinton; Parrot, 1940 : 312.
Sergentomyia (*Sintonius*) *christophersi* (Sinton); Theodor & Mesghali, 1964 : 297 [cibarium]; Lewis, 1967 : 40; 1974*b* : 195; Artemiev, 1976*a* : 35.
Phlebotonus (*Sergentomyia*) *christophersi* Sinton; Abonnenc, 1972 : 152.

The cibarium of the female has large cornua, four or five separated teeth and a very small pigment patch.

♀ (*extra facts*). Labrum with unusual pattern of adoral and cibarial sensilla. Hypopharynx smooth. Mandible pointed and slender. Maxilla with small teeth, seven lateral, 27 ventral and a dental depth of 0·12 mm.

In view of observations by Theodor & Mesghali on the fore teeth, a few females from several countries were examined. None was found in those from Kenya, India, Morocco, Pakistan, Sudan, Uganda or Yemen. There were distinct teeth in a female from Iran, and minute teeth in one from Ethiopia.

MATERIAL EXAMINED.
Pakistan: Lahore. Others as indicated above.

DISTRIBUTION. **India:** Jaipur (Kaul *et al.*, 1973 : 532); Bikaner (Sharma *et al.*, 1973*c*); Delhi, Karnal, Pinjaur, Pipli, Sahranpur (Sinton's notes). **Pakistan:** Jhelum, Lahore (Lewis, 1967 : 40).

Sergentomyia (*Sintonius*) *clydei* (Sinton)

(Figs 266, 267, Map 13)

Phlebotonus clydei Sinton, 1928*b* : 179; 1928*c* : 312; 1932*a* : 60; 1932*b* : 571; 1932*c* : 579; 1933*e* : 420. Lectotype ♂, PAKISTAN (BMNH), designated by Lewis, 1967 : 42 [examined].
Phlebotomus (*Prophlebotomus*) *clydei* Sinton; Parrot, 1940 : 312; 1946 : 71; 1953 : 112.
Sergentomyia (*Sintonius*) *clydei* (Sinton); Theodor, 1958 : 51; Theodor & Mesghali, 1964 : 297; Lewis, 1967 : 42; Perfil'ev, 1968 : 347; Artemiev, 1976*a* : 37.

The female has 10–15 cibarial teeth and an almost unarmed pharynx, and the male has small cibarial spicules arranged in groups. Among specimens from Tibi, Rajasthan, India, the cibarial fore and hind teeth of females are large, and the length of abdominal tergite 6 of the males is variable.

♀ (*extra facts*). Hypopharynx with long low blunt teeth. Mandible pointed. Maxilla with three lateral teeth, one very small, and a gap between them and the 30 ventrals, dental depth 0·09 mm.

The subgeneric character of a small number of erect hairs on abdominal tergites 2–6 is often inapplicable to males of *S. clydei*. Sinton mentioned four to six erect hairs on segment 3 and fewer behind. In some specimens, examined from the side and from above, there are two erect hairs on tergite 2 and none behind. Tergite 6 normally bears no hairs but small and very small microtrichia.

MATERIAL EXAMINED.
Pakistan: Bazid Khel, drawn.

DISTRIBUTION. **India:** Keliveli, Osmanabad (*V. Dhanda*); Ajmer (Jaswant Singh, 1933); Jaipur, Jalor (Kaul *et al.*, 1973 : 533); Venkatapuram (10.vii.1966, in house on human bait, *R. Reuben*); Tibi (Sharma

et al., 1973*b*); Bikaner (Sharma *et al.*, 1973*c*); Bhavnagar, Delhi, Guntur, Junagadh, Kamptee, Karnal, Madras, Pipli, Sahranpur (Sinton's notes). **Pakistan:** Kandhkot, Karachi, Khairpur, Lahore, Mir Muhammad, Peshawar, Rawalpindi, Tando Muhammad Khan, Taxla (Lewis, 1967 : 42); Jandola, Khirgi (Sinton, 1928*b* : 179); Sargodha (Sinton's notes).

Sinton (1932*c* : 71) found *S. clydei* widely in the plains of India.

Sergentomyia (*Sintonius*) *eadithae* (Sinton)

(Fig. 268, Map 13)

Phlebotomus eadithae Sinton, 1932*c* : 577 [♀]; 1933*c* : 227; 1933*e* : 420 [♂]; Parrot, 1940 : 312. LECTOTYPE ♀, India (Sagar ?), labelled 'P. 4 . . . Type ♀ Saugor . . . 3/8/27' (BMNH), here designated [examined].

The female has about 35 large pointed cibarial teeth, in a row distinctly convex near the middle, a large pigment patch, minute pharyngeal teeth, and a long spermatheca with about 12 segments and a small head.

♀ (*extra facts*). Labrum about 0·19 mm long, 0·10 length of wing. Hypopharynx smooth with narrow forward part. Mandible rather blunt. Maxilla with 11 lateral teeth, not very wide, 24 ventrals and a dental depth of 0·09 mm.

Distribution. **India:** Sirohi (Kaul *et al.*, 1973 : 533); Hyderabad (2 ♂, Qutubuddin, 1944 : 208); Sagar (Madyia Pradesh, Sinton, 1932*c* : 577); Velur (Todupuzha, Travancore, Sinton's notes).

Sergentomyia (*Sintonius*) *hospitii* (Sinton)

(Figs 269–273, Map 13)

Phlebotomus simillimus var. *hospitii* Sinton, 1924*g* : 261; 1927*d* : 22, 27 [spermatheca]; 1927*e* : 30 [cibarium]; 1928*c* : 312. Lectotype ♂, Pakistan (BMNH), designated by Lewis, 1967 : 44 [examined].
Phlebotomus hospitii Sinton; Sinton, 1929*b* : 174; 1932*a* : 60; 1933*d* : 420; Theodor, 1938*b* : 172 [relationship to *S. thompsoni* Theodor].
Sergentomyia (*Sintonius*) *hospitii* (Sinton); Lewis, 1967 : 43.

The female has 50–60 cibarial teeth, and both sexes have spines on femur 1.

♀ (*extra facts*). Labrum with, on each side, three apical sensilla, each comprising a basal refractive cup, a leaf-like process with narrow shoulders; two very small subapical sensilla, each having, like the apicals, a canal through the labral cuticle; a row of narrow adoral sensilla; a few small adorals near the mid line beneath the tip of the clypeus; and the usual round cibarial sensilla. Hypopharynx narrow anteriorly and without teeth. Maxilla with 12 broad lateral teeth and no ventrals apart from a few vestigial specks.

Material examined.
Pakistan: Said Pur, 1 ♀.

Distribution. **India:** Almora area, Kasauli (Sinton's notes). **Pakistan:** Abbottabad, Dulai, Rawalpindi, Said Pur (Lewis, 1967 : 44).

This species was known only from the western Himalayan foothills (Sinton, 1932*a*).

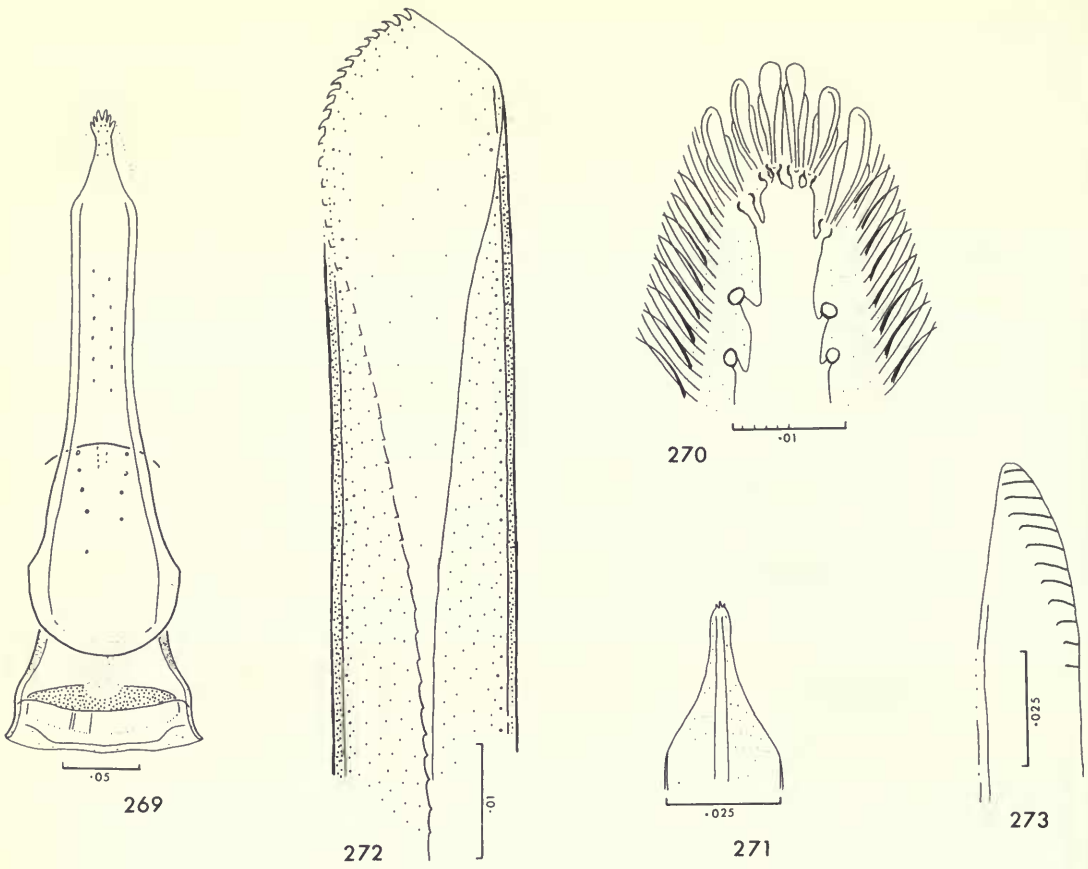
Sergentomyia (*Sintonius*) *orissa* Kaul & Lewis

(Map 13)

Sergentomyia (*Sintonius*) *orissa* Kaul & Lewis, 1977 : 83. Holotype ♀, India (BMNH) [examined].

The female has 24–28 cibarial teeth, more or fewer than those of other Oriental *Sintonius*.

Distribution. **India:** Bhubaneswar area.



Figs 269–273 *Sergentomyia hospitii*, ♀: (269) labrocibarium; (270) tip of labrum; (271) tip of hypopharynx; (272) tip of mandible; (273) tip of maxilla.

Sergentomyia (*Sintonius*) *sirohi* Kaul, Dhanda & Modi

(Map 13)

Sergentomyia (*Sintonius*) *sirohi* Kaul, Dhanda & Modi, 1973 : 533. Holotype ♀, INDIA (presumed in Virus Research Centre, Poona) [not examined].

In this small species the female has 10–12 spaced pointed teeth and usually (unlike *tiberiadis*) no fore teeth.

DISTRIBUTION. **India:** Veerwada (Kaul *et al.*, 1973 : 535).

Sergentomyia (*Sintonius*) *tiberiadis* (Adler, Theodor & Lourie)

Phlebotomus species near *clydei* (Sinton); Adler & Theodor, 1929 : 284.
Phlebotomus tiberiadis Adler, Theodor & Lourie, 1930 : 537; Sinton, 1932*c* : 579. Syntypes, ISRAEL (TC) [not examined].
Sergentomyia (*Sintonius*) *tiberiadis* (Adler, Theodor & Lourie); Theodor, 1958 : 51.

The female has 10–18 cibarial teeth in comb formation, the middle ones being smaller than the laterals.

Sergentomyia* (*Sintonius*) *tiberiadis pakistanica Artemiev & Saf'yanova

(Map 13)

Sergentomyia (*Sintonius*) *tiberiadis* (Adler, Theodor & Lourie); Theodor & Mesghali, 1964 : 297 [Afghanistan]; Lewis, 1967 : 44.

Sergentomyia (*Sintonius*) *tiberiadis pakistanica* Artemiev & Saf'yanova, 1974 : 544; Artemiev, 1976*a* : 38. Syntypes 19 ♀, 33 ♂, AFGHANISTAN AND U.S.S.R. (depository unknown) [not examined].

This subspecies differs from the Ethiopian and Israel nominal subspecies in having a spermatheca narrowing toward the tip with more (9–12) segments, a common spermathecal duct, and 13 (10–17) cibarial teeth instead of 17–18. The authors raised the eastern form to subspecies after considering its morphology and probable allopatricity.

♀ (*extra facts*). Hypopharynx smooth. Maxilla with six, not very broad, lateral teeth, 27 minute ventrals, and a dental depth of 0·10 mm.

MATERIAL EXAMINED.
Pakistan: Ahmed Khel, 1 ♀.

DISTRIBUTION. **Pakistan:** Ahmed Khel, Landi Kotal, Peshawar (Lewis, 1967 : 46).

Nomen nudum

Phlebotomus javanensis Flu, 1920 : 602; Sinton, 1928*c* : 322 (as *javaensis*); Lewis, 1973*a* : 254.

Flu wrote; 'Phlebotomus papatacci komt op Java voor en is er b. v. door Professor de Meyere beschreven onder de naam van phlebotomus javanensis' (Phlebotomus papatacci occurs on the island of Java and has been described as phlebotomus javanensis by Professor de Meyere). *P. papatasi* is unknown in this part of the world and the name *javanensis* is a nomen nudum.

Aspects of biology

Much information on the biology of certain Oriental species is available in the literature, and some of it has been summarized by Forattini (1973). The following paragraphs deal mainly with general distribution, blood-feeding habits and seasonal distribution which is an essential consideration in planning collecting expeditions.

General distribution

The limits of the Oriental Region used here are those of Delfinado & Hardy (see Lewis, 1973*a*) except for the inclusion of Baltistan in Pakistan. The peripheral areas include Pakistan, Nepal, Burma, a southern Chinese belt, Taiwan, Philippines, Mangole Island, Babar Island, Indonesia and Sri Lanka. The subregions were defined by Wallace (1876 : maps 1 and 10) and Bartholomew *et al.* (1911 : pl. I). The north-eastern boundary was discussed by Chang (1965), and all aspects of Indian zoogeography have been reviewed by Mani (1974). Christophers (1921*a*; 1923) discussed mosquito distribution in India and emphasized east–west faunal changes on the lower Indus and in the Sylhet area, a Malabar fauna with affinities in Sri Lanka and east of Calcutta, and a relationship between Himalayan and more eastern forests.

Many species of sandflies occur mainly, not in a particular faunal region, but in parts of three regions, which together make up a vast zone with its axis running from Morocco to India. For ease of discussion this area is here named the Triad Zone, and its approximate boundaries (clockwise from West Africa) are: the Atlantic, 48° N, 90° E and 10° N. Its core is the 'Saharan' district of Christophers (1921*b* : 714, Map III) and the Mediterranean Subregion of the Palaearctic (Christophers, 1923 : 422). The northern limit of this mainly rather dry zone approximates to the cold northern boundary of sandflies, and the eastern and southern limits to the 1000 mm isohyet.

The Oriental Region is here divided into the west (Indian and Ceylonese Subregions), centre (Indo-Chinese and Indo-Malayan Subregions, excluding Borneo and the Philippines) and east (Borneo and the Philippines).

Table 1 and the maps show a relation between distribution and certain taxonomic groupings, and indicate that most species occur largely in either the west, centre or east, but few in both west and centre. Combining west with Triad, centre with Palaearctic (Manchurian) and east with Australasian gives the following figures (percentages in brackets): west, 43 (35·8); centre, 42 (35·0), east, 35 (29·2), and west plus centre, 4 (3.2).

Table 1 The Oriental Phlebotominae showing the *main* area of each in the Old World. The term Triad Zone is explained in the section on general distribution (p. 311), and many of its sandflies are widespread in the west of the Orient. For the subgenera *Parrotomyia* and *Neophlebotomus* code letters are used to indicate groupings mentioned in the text

		Oriental					
	Triad Zone	West	Centre	East	West and Centre	Palaearctic: Manchurian	Australasian
PHLEBOTOMUS							
(*PHLEBOTOMUS*)							
papatasi	+	−	−	−	−	−	−
salehi	+	−	−	−	−	−	−
(*PARAPHLEBOTOMUS*)							
alexandri	+	−	−	−	−	−	−
nuri	−	+	−	−	−	−	−
sergenti	+	−	−	−	−	−	−
(*SYNPHLEBOTOMUS*)							
eleanorae	−	+	−	−	−	−	−
(*LARROUSSIUS*)							
betisi	−	−	+	−	−	−	−
kandelakii burneyi	−	+	−	−	−	−	−
keshishiani	+	−	−	−	−	−	−
major major	−	+	−	−	−	−	−
(*ADLERIUS*)							
chinensis chinensis	−	−	−	−	−	+	−
longiductus	+	−	−	−	−	−	−
(*EUPHLEBOTOMUS*)							
argentipes	−	−	−	−	+	−	−
kiangsuensis	−	−	+	−	−	−	−
philippinensis gouldi	−	−	+	−	−	−	−
philippinensis philippinensis	−	−	−	+	−	−	−
(*ANAPHLEBOTOMUS*)							
colabaensis	−	+	−	−	−	−	−
hoepplii	−	−	−	+	−	−	−
stantoni	−	−	−	−	+	−	−
Ungrouped							
newsteadi	−	+	−	−	−	−	−
(*IDIOPHLEBOTOMUS*)							
asperulus	−	−	+	−	−	−	−
erebicolus	−	−	−	+	−	−	−
frondifer	−	−	+	−	−	−	−
pholetor	−	−	−	+	−	−	−
sejunctus	−	−	−	+	−	−	−
stellae	−	−	−	+	−	−	−
teshi	−	+	−	−	−	−	−
tubifer	−	+	−	−	−	−	−
SERGENTOMYIA							
(*musai*-group)							
musai	−	−	−	+	−	−	−

Table 1 (*cont.*)

		Triad Zone	Oriental				Palae-arctic: Man-churian	Austral-asian
			West	Centre	East	West and Centre		
(*SERGENTOMYIA*)								
dentata		+	−	−	−	−	−	−
punjabensis		−	+	−	−	−	−	−
theodori pashtunica		+	−	−	−	−	−	−
(*PARROTOMYIA*)								
A sp.	a	−	+	−	−	−	−	−
africana magna	a	+	−	−	−	−	−	−
B sp.	a	−	+	−	−	−	−	−
babu babu	b	−	+	−	−	−	−	−
babu insularis	b	−	+	−	−	−	−	−
baghdadis	b	+	−	−	−	−	−	−
barraudi	a	−	−	+	−	−	−	−
bigtii	a	−	−	−	+	−	−	−
brevicaulis	a	−	−	+	−	−	−	−
brevinervis	a	−	−	−	+	−	−	−
bukidnonis	a	−	−	−	+	−	−	−
dayapensis	a	−	−	−	+	−	−	−
denticulata	d	−	−	−	+	−	−	−
franciscana	a	−	−	−	+	−	−	−
grekovi	g	+	−	−	−	−	−	−
himalayensis	a	−	+	−	−	−	−	−
kauli	a	−	+	−	−	−	−	−
mangana	a	−	−	−	+	−	−	−
modii	a	−	−	+	−	−	−	−
palestinensis	g	+	−	−	−	−	−	−
queenslandi meridionalis	a	−	−	−	−	−	−	+
rudnicki	d	−	−	+	−	−	−	−
shorttii	b	−	+	−	−	−	−	−
spinifaucis	a	−	−	−	+	−	−	−
timorica	a	−	−	+	−	−	−	−
torrechantei	a	−	−	−	+	−	−	−
yoshimotoi	a	−	−	−	+	−	−	−
(*GRASSOMYIA*)								
indica		−	−	−	−	+	−	−
(*NEOPHLEBOTOMUS*)								
arboris	ar	−	+	−	−	−	−	−
balica	ba	−	−	+	−	−	−	−
Besout sp.	un	−	−	+	−	−	−	−
chakravarti	dh	−	+	−	−	−	−	−
dhandai	dh	−	+	−	−	−	−	−
gemmea	ar	−	−	+	−	−	−	−
gombaki	ar	−	−	+	−	−	−	−
hamidi	un	−	−	+	−	−	−	−
hodgsoni hodgsoni	ba	−	+	−	−	−	−	−
iyengari	dh	−	−	+	−	−	−	−
jefferyi	ba	−	−	+	−	−	−	−
khawi	ba	−	−	−	−	−	+	−
linearis	dh	−	+	−	−	−	−	−
malabarica	dh	−	+	−	−	−	−	−
malayae	ar	−	−	+	−	−	−	−
nankingensis	ba	−	−	+	−	−	−	−

Table 1 (*cont.*)

			Oriental					
		Triad Zone	West	Centre	East	West and Centre	Palaearctic: Manchurian	Australasian
perturbans	qu	–	–	+	–	–	–	–
purii	qu	–	+	–	–	–	–	–
quatei	qu	–	–	–	+	–	–	–
Rabok sp.	un	–	–	+	–	–	–	–
Sepilok sp.	un	–	–	–	+	–	–	–
silvatica	qu	–	–	+	–	–	–	–
tambori	ba	–	–	+	–	–	–	–
tonkinensis	qu	–	–	+	–	–	–	–
traubi	qu	–	–	+	–	–	–	–
zeylanica	ar	–	–	+	–	–	–	–
(*nicnic*-group)								
bailyi		–	–	–	–	+	–	–
displicata		–	–	–	+	–	–	–
kachekensis		–	–	–	+	–	–	–
nicnic		–	–	–	+	–	–	–
(ungrouped)								
angustipennis		–	–	+	–	–	–	–
anodontis		–	–	+	–	–	–	–
cheongi		–	–	+	–	–	–	–
dapsilidentes		–	–	–	+	–	–	–
delfinadoae		–	–	–	+	–	–	–
dentacea		–	–	–	+	–	–	–
exastis		–	–	–	+	–	–	–
fanglianensis		–	–	+	–	–	–	–
hassani		–	–	+	–	–	–	–
heiseri		–	–	–	+	–	–	–
hitchensi		–	–	–	+	–	–	–
imitor		–	–	–	+	–	–	–
jamesi		–	–	+	–	–	–	–
kelantani		–	–	+	–	–	–	–
knudseni		–	–	+	–	–	–	–
lagunensis		–	–	–	+	–	–	–
losarcus		–	–	–	+	–	–	–
maai		–	–	–	+	–	–	–
mahadevani		–	–	+	–	–	–	–
montana		–	+	–	–	–	–	–
morini		–	–	+	–	–	–	–
neras		–	–	–	+	–	–	–
Okinawa sp.		–	–	+	–	–	–	–
pachystoma		–	–	+	–	–	–	–
pooi		–	–	+	–	–	–	–
reidi		–	–	+	–	–	–	–
tracheola		–	–	–	+	–	–	–
(*SINTONIUS*)								
christophersi		+	–	–	–	–	–	–
clydei		+	–	–	–	–	–	–
eadithae		–	+	–	–	–	–	–
hospitii		–	+	–	–	–	–	–
orissa		–	+	–	–	–	–	–
sirohi		–	+	–	–	–	–	–
tiberiadis pakistanica		–	+	–	–	–	–	–

Table 2 Latitude and longitude (degrees and minutes) of localities not shown in their original spelling in the 1972 *Times Atlas*. All latitudes, except for Java and Nusa Tenggara, are north, and all longitudes east

	Latitude	Longitude
ANDAMAN ISLANDS		
Chinya Tapu	11 41	92 43
BANGLADESH		
Bongong, Tessore area, c.	23 10	89 12
Dhurmakura, Mymensingh area = Nasirabad, c.	24 45	90 23
Doloi Valley = Dhalai ? c.	24 20	91 50
Kaoraid, near Dacca, c.	23 42	90 22
BORNEO: Sabah		
Gomantong	5 32	118 03
Sepilok	5 50	117 22
BURMA		
Mezali, Minbu district, c.	20 09	84 52
CHINA		
Fanglian, Hainan Island, c.	18 30	110 00
Kachek	19 19	110 22
Kukong	24 59	113 10
Lin Ko	19 54	109 43
Masha	27 32	117 53
Nanking = Nan-ching	24 26	117 20
Sainan	23 09	112 52
Samshui county = Ho-k'ou, Kwantung	23 11	112 52
Suilam = Siulam	22 40	113 29
Tche-Souen = Se-Tchouen = Chechuan = Chih-ts'un	23 20	103 30
Tienpao	23 20	106 37
Yungan	25 57	117 18
INDIA		
Aligarh, Uttar Pradesh	27 54	78 04
Baraga, Sagar (Shimoga) area, c.	14 07	75 00
Borghat	18 48	73 28
Hoora, Sagar (Shimoga) area, c.	18 00	73 05
Hosur	14 39	75 07
Jog = Gersoppa	14 12	74 51
Kannur, Sagar (Shimoga) area	14 17	35 10
Keliveli, Akola area, c.	20 40	77 05
Konehosur, Sagar (Shimoga) area, c.	14 07	75 00
Kotelanka	16 43	81 17
Kulathurpuzha	8 54	77 03
Kumsi, Sagar (Shimoga) area, c.	14 07	75 00
Mendhar	33 40	74 08
Mohindergarh = Mahendragarh, Hariana	28 17	76 14
Munikeriti, c.	30 21	78 29
Naushera, Kashmir	33 10	74 12
Nedumangad	8 36	77 01
Paloc	8 42	77 02
Panada-Agraharam	16 32	81 35
Panchgani	17 15	73 15
Patan	19 37	75 26
Pipariya, c.	23 00	73 00
Poladpur	18 00	73 25
Rajouri	33 25	74 18
Ramanagar, Naini Tal area, c.	29 22	79 26
Sagar, Madhya Pradesh	23 50	78 44
Sanawar, Simla area, c.	31 07	77 09
Singanama, c.	21 00	79 00
Soraipani, tea estate near Mariani in Jorhat area, c.	26 38	94 18
Sukna, Darjeeling area, c.	27 02	88 20
Tamilnadu = formerly Madras State	—	—
Tindharia	26 53	88 22
Travancore = former State now in Kerala	—	—
Undi	16 35	81 28
Veerwada, Sirohi area, c.	25 53	72 58
Velur, Todupuzha, Travancore, very approximately	9 00	77 00
Wadhwan = Surendranagar	22 44	71 43
NEPAL		
Chobhar, c.	27 40	85 13
Dhunibesi, near Kathmandu, c.	27 42	85 19
Syabrudens, c.	28 10	85 08
NUSA TENGGARA		
Kabara, c.	10 02	120 44
Los Palos	8 35	126 47
Pedang Bay	8 20	115 25
Same	9 06	125 48
Suai	9 21	125 17
Sumba	8 47	120 24
Tafara Cape	9 21	125 17
PAKISTAN		
Ahmed Khel, Peshawar area, c.	34 01	71 40
Bazid Khel, Peshawar area, c.	34 01	71 40
Bahrein	34 53	72 35
Dulai	34 14	73 30
Gol	35 16	75 20
Gwadi	35 12	76 10
Khaira Gali	33 40	73 20
Khairpur, Khairpur district,	27 30	68 50

Table 2 (*cont*)

	Latitude	Longitude
Kohat area (Kohat-Hangu valley), c.	33 34	71 15
Mir Muhammad	31 40	74 15
Parkuta	35 07	76 00
Said Pur	33 17	72 58
Saidu Sharif	33 40	72 30
PHILIPPINES		
Apali, c.	13 30	123 20
Bay, c.	14 20	121 20
Bigti, Angat and Norzagaray area, c.	14 55	121 01
Cuernos de Negros	9 14	123 10
Dayap, c.	14 10	120 20
Jose del Monte, c.	14 48	121 12
Katanglad Mountain	8 07	124 55
La Mesa dam, c.	14 50	121 10
Los Arcos	8 39	125 59
Los Baños, c.	14 20	121 10
Malinao, c.	13 30	123 20
Minglanilla	10 15	123 47
Nueva Viscaya	16 20	121 20
San Francisco, Agusan area, c.	9 00	125 40
San Mateo	14 42	121 08
Silang, c.	14 10	120 50
Sipocot, c.	13 30	123 20
Tala, c.	14 50	121 07
Tarampitao	9 10	117 40
Tungkong Manga (district)	14 48	121 12
SRI LANKA		
Depanama	6 51	79 57
Kalgoda, prob.	6 52	79 57
Katuwawala	6 49	79 54
Maharagama, c.	7 12	80 04
Pannipitiya	6 51	79 57
TAIWAN		
Tzepeng, c.	23 01	120 14
THAILAND		
Ban Bon Dan	14 32	101 58
Doi Sutep = Ban Bon Doi Sutep	18 48	98 55
Khou Kaen Prov. = Mwang Khou Kaen	16 25	102 50
Meung dist. near Vientiane, c.	17 59	102 38
Meung dist. NE. of Bangkok = Nakhon Rotchasima area, c.	15 08	102 06
Pechaburi	13 06	99 57
Tha Li district = Ban Tha Li	17 37	101 32
VIETNAM (NORTH)		
Bac Muc	22 04	105 01
Bim Son	20 00	105 50
Bui Huy Tin, Bim Son area, c.	20 00	105 50
Cho Ganh	20 12	105 50
Coc Leu	22 28	103 58
Dong Giao	20 03	105 57
Kep	21 23	106 15
Lam	21 20	106 30
Le Mi	21 35	105 15
Nao Phu	21 25	105 20
Pho Doan	21 22	105 12
Pho Moi	22 24	104 02
Pho Oc	20 07	105 53
Vin Thui	22 17	104 53
Yen Ley	20 30	105 38
WEST MALAYSIA		
Batang Padang	4 14	101 21
Betis	4 55	101 45
Bukit Ibam, c.	3 10	103 15
Carey Island	3 01	101 38
Gua 'Che Yatim, c.	4 30	102 10
Gunong Besout Forest Reserve	3 49	101 12
Kuala Rompin, c.	2 40	103 30
Kuala Trengan	4 30	102 25
Lamir, Kampong or village, Kuantan area	3 31	102 43
Lubok Paku, Kuantan area c.	3 50	103 19
Pulau Meranti, Kampong, Bruas area, c.	4 29	100 50
Rantau Panjang, c.	3 10	101 25
Tanjong Rabok	2 09	101 24
Terenggan, Pahang, c.	3 00	103 00
Ulu Gombak	3 19	101 46
Ulu Langat	3 07	101 49

The western Orient

The western area has probably received many species from the Mediterranean subregion of the Palaearctic and from the Triad Zone generally, under the influence of increasing aridity. Many of the species belong to *Phlebotomus* or to the subgenera *Sergentomyia* or *Sintonius* of *Sergentomyia*. *P. papatasi*, perhaps owing to its domestic habit, has penetrated far into the western

Table 3 Showing the percentages of females in five collections

	INDIA	WEST MALAYSIA			THAILAND
	Sagar (Shimoga) area	Gunong Besout area	Bukit Igam area	Lamir village	Ban Bon Dan
PHLEBOTOMUS					
argentipes	3·1	—	—	100·0	60
philippinensis gouldi	—	—	—	—	20
stantoni	0·8	0·78	—	—	—
frondifer	—	0·45	—	—	—
SERGENTOMYIA					
babu and variant	33·4	—	—	—	—
barraudi	—	7·90	1·5	—	—
himalayensis or ally	1·2	—	—	—	—
shorttii	10·7	—	—	—	—
arboris	7·5	—	—	—	—
gemmea	—	0·56	—	—	—
gombaki	—	47·02	4·4	—	—
hamidi	—	0·66	21·0	—	—
iyengari	—	9·45	0·7	—	—
jefferyi	—	3·78	4·4	—	—
linearis	2·7	—	—	—	—
malayae	—	2·78	—	—	—
perturbans	—	5·00	—	—	—
silvatica	—	—	—	—	10
tambori	—	0·33	—	—	—
traubi	—	—	53·7	—	—
bailyi	44·8	—	—	—	—
cheongi	—	5·89	—	—	—
hassani	—	—	5·1	—	—
knudseni	—	2·33	—	—	—
mahadevani	—	—	—	—	10
pachystoma	—	0·18	2·2	—	—
reidi	—	11·34	6·5	—	—
Totals	261	900	138	448	10

Orient, where it occurs in an area with an annual mean relative humidity of less than 70 per cent (Sivaramakrishnaiah & Ramanathan, 1967 : 1166).

The wet area of the Western Ghats lacks some dry-adapted species but harbours some woodland forms known in the central Orient. The *S. arboris* series in India forms a reversed-'C' distribution pattern, with Sri Lanka in the lower arm, and is thus comparable with the *Anopheles leucosphyrus* Dönitz group (Covell, 1927 : 47; Reid, 1970 : 60).

Two species comprised most of the collection (Table 3) made by H. Trapido in 1957 in the Sagar (Shimoga) area which lies between 564 and 609 m above sea level (Work *et al.*, 1957 : 620).

The central Orient

The centre was formerly connected to Africa by forest which persisted in north-west Indo-Pakistan till historical times (Traub & Twisseman, 1966 : 47, 48). Theodor (1938*b* : 172) drew attention to the affinity between the Oriental and Ethiopian sandfly faunas, and many species of the central Oriental area belong to *Neophlebotomus* which is well represented in the Ethiopian forest zone. This is illustrated in Table 3 which shows collections made by A. B. Knudsen, R. B.

Tesh and colleagues in the Gunong Besout area, and by L. W. Quate in the Bukit Ibam area (including Kuala Rompin and Gua 'Che Yatim). There is thus a parallel with the Oriental anopheline mosquitoes which were once linked by forest with the essentially primitive species of the Afrotropical forest (Gillies & de Meillon, 1968 : 321). Similarly, the *Diceromyia* culicines have evidently spread into both Afrotropical and Oriental Regions long ago and developed separate species (Reinert, 1970).

The central area has evidently received a number of species from the Manchurian Subregion of the Palaearctic (Lewis & Wharton, 1963 : 117), which has a rich insect fauna (Gressitt, 1958 : 213) differing from that of the Mediterranean Subregion owing to the intervening inhospitable Siberian Subregion. These two different Palaearctic sources and climatic differences between the western and central Oriental areas give them rather distinctive sandfly faunas.

The central area (Table 3, columns 2 and 3), like the eastern, has a considerable number of ungrouped species of *Sergentomyia*. Australasian influence is small, presumably because even narrow seas can form a strong barrier to weakly flying sandflies, although many of these insects can occupy land barriers between regions.

West and central areas in general

P. argentipes is related to species of the Palaearctic Manchurian Subregion and of the eastern Orient, and it may have extended to the far west by virtue of its peridomestic habit there. Its wide distribution may be somewhat comparable with that of the more domestic *P. papatasi* in the Old World. *P. argentipes* has a patchy distribution in India (Smith, 1959 : 17) and in the Orient generally. Collections by R. H. Wharton at Lamir and by D. J. Gould in Thailand (Table 3) exemplify this and point to the need for further study. The Lamir result could have been due to seasonal or other changes, for no *P. argentipes* was found during a later visit (Lewis & Killick-Kendrick, 1973).

S. indica is closely related to all other members of the small subgenus *Grassomyia* which reaches from Dakar on the Atlantic to Timor, 144° or some 16 000 km. *S. indica* is one of the species which show distinctive features of structure, distribution and biology.

The environment of India (Mani, 1974 : 54) and some other countries has been greatly altered by deforestation and agriculture. Certain areas now have few phlebotomines, and Raynal did not find many in the lowlands of North Vietnam. West-central Taiwan (Cates & Lien, 1970 : 540) is probably an example of the same trend.

The eastern Orient

Wallace (1876 : I, 315) found the Philippines strikingly deficient in many Malayan animals, with an approach to the Sulawesi (Celebes) fauna, and Corbet & Pendlebury (1956 : 26) emphasized differences between Borneo and the Philippines. Their sandfly faunas differ from each other, apart from one species, but the Borneo sandflies are little known.

Most species of the cave-dwelling subgenus *Idiophlebotomus* are known from the eastern Orient, but it is represented in India and West Malaysia and probably constitutes an ancient relict fauna.

No sandfly of the eastern area is known from Australasia.

Breeding habits

Sandfly larvae were discovered in August 1908 (Howlett, 1909 : 239), but are usually difficult or impossible to locate. In the western Orient Napier & Smith (1926), Carter & Antonipulle (1949) and others have collected those of *P. argentipes* around houses. Nowadays biological information is being gained through laboratory colonization, and work on *P. papatasi* and *P. argentipes* has been summarized by Killick-Kendrick *et al.* (1977).

Adult resting sites

Most sandflies are wild and shelter in natural sites such as holes in trees or among stones and rocks, soil cracks and animal burrows. Holes in termite hills have attracted attention in Kenya

where they harbour the vector of 'termite hill kala-azar' (Lewis, 1974*a* : 369). In Pakistan Lewis (1967 : 49) found sandflies in termitaries at Lahore. In India Howlett (1913) found many sandflies in termite mounds and Modi & Dhanda (1972) reported seven species from termitaries in Maharashtra. In the Philippines Quate (1965 : 18) often found sandflies associated with termites.

A few species are largely domestic or peridomestic, resting in dwellings by day after feeding on man, domestic animals or geckos. *P. papatasi* is an important domestic species, and in Poona, Mitra (1956) found it mainly in houses and *P. argentipes* mainly in stables. *P. sergenti* is largely domestic. *P. argentipes*, in most of its range outside India and Sri Lanka, is seldom seen and appears to be a woodland zoophilic and exophilic species. In India *P. argentipes* was not found in the outdoor survey by Kaul *et al.* (1976), and is known to be largely peridomestic and to bite man but to prefer cattle. It may be that in the western Orient relatively dry conditions have driven this species into peridomestic situations.

Raynal (1936*a*) in Indo-China found *P. stantoni* rarely indoors, but *S. barraudi* often around houses. Tang & Maa (1945) encountered *P. hoepplii* in houses.

Food of adults

Plant sugars are probably taken by most sandflies (Lewis, 1966; 1971 : 543), and the subject was long ago brought to prominence in India (Berberian, 1966) by the effect of fruit juice on the transmission of *Leishmania donovani* by *P. argentipes*. An extraneous cap seen on the fascicle of an American species (Lewis, 1975*a* : 511) may have been acquired during plant feeding, and a similar cap was seen on a female of *S. gemmea* from the Gunong Besout area. Sandflies have been reported to feed on caterpillars (Howlett, 1909 : 240), and two females to bite a large moth in Africa (Kirk & Lewis, 1940 : 632; Quate, 1964 : 233; W. Ruttledge, 1965, verbal communication). *S. bailyi*, as noted below, may bite insects.

Vertebrate blood is usually taken by females but the male of *P. argentipes* can suck blood from a puncture wound (Smith, 1959 : 19) and, as noted above, has been taken with biting females in India.

It is well known that many species of *Phlebotomus* bite mammals, and that at least some species of *Sergentomyia* attack lizards or other cold-blooded animals, some feed from amphibia and some from birds. Some mammal-biters feed from a range of species. Certain mammal-biters occasionally bite lizards, and vice versa, and a few African species of *Sergentomyia* sometimes attack man. One American sandfly which normally feeds on wild mammals occasionally bites man, apparently when its normal host is absent (Lewis, 1974*a* : 377), and this type of behaviour may account for some of the records of Oriental *Sergentomyia* biting man.

P. papatasi and *P. sergenti* feed on man in many parts of the Old World. George (1970) showed that the former is primarily anthropophilic in the Lahore and Peshawar areas but can also feed on birds, bovines, dogs and equines, and that *P. sergenti* can feed on birds, bovines and man. Around Aurangabad, Dhanda & Modi (1971 : 1568) showed that most *P. papatasi* fed on man, and a few on cattle, dogs and birds, and Pandyia *et al.* (1972) reported it biting cattle.

With regard to *P. argentipes* in India, Lloyd *et al.* (1925) reported that around Calcutta it bit cattle mainly, and man occasionally, and Napier & Smith (1926) considered that it fed mainly on man and cattle. Lloyd & Napier (1930) observed that *P. argentipes* fed almost entirely on man and cattle. Controversy then developed (Shortt, 1931*a* : 1047–1049; 1931*b*; Napier, 1931) concerning identification of sandflies and the reliability of blood-identification methods. *P. argentipes* in the laboratory was found to be able to bite mice and rabbits (Kala-azar Commission, 1932) and chickens (Bhattacharya *et al.*, 1951). It has been taken on a pony (noted under Distribution). Dogs are unattractive to *P. argentipes* according to Smith (1959 : 19), and Garnham (1965 : 145) discussed the freedom of Indian dogs from *L. donovani* in this connection. Dhanda & Modi (1971 : 1568) found that *P. argentipes* in the Aurangabad area bit cattle mainly and man to some extent, and Pandiya *et al.* (1972) reported that it bit cattle in Gujarat. Man-biting by this species in rural India, where man and cattle are often closely associated, resembles the habits of *P. longipes* Parrot & Martin in Ethiopia (Foster *et al.*, 1972 : 440).

In Bengal, Das & Mukherjee (1969*b*) considered that *P. argentipes* had become more zoophilic than before. Bray (1974 : 73) suggested that either it had been diverted to cattle by irritability to anti-malarial DDT in houses, or that it was a complex containing an anthropophilic form which had been controlled. Sen Gupta (1975) reported that, although about 1960 laboratory-reared sandflies would very rarely feed on man, females with human blood had recently been found in living rooms. It may be that for some years *P. argentipes* had undergone a change like that which overtook a mosquito of the Solomon Islands (Taylor, 1975 : 287).

In Sri Lanka *P. argentipes* occurs in cow sheds but does not seem to bite man readily (Lewis & Killick-Kendrick, 1973).

In West Malaysia *P. argentipes* has been found on cattle and attacking human bait (Lewis, 1957 : 166). Lewis & Wharton (1963) reported that it fed on cows but had rarely been found biting man.

P. kiangsuensis can bite man out of doors in West Malaysia and may perhaps attack bats (Lewis & Wharton, 1963 : 120, 124).

Tang & Maa (1945) found that *P. hoeppli* was attracted to human bait and probably bit man.

Raynal (1936*a* : 360) found that *P. stantoni* fed on mammals, probably rodents, and Parrot & Clastrier (1952 : 153) suggested that it might bite man.

P. betisi bit man in a West Malaysian cave but might normally feed on bats (Lewis & Wharton, 1963 : 118, 123, 124).

Species of subgenus *Idiophlebotomus* probably feed on bats (Lewis & Lane, 1976).

With regard to *Sergentomyia*, early reports of '*P. minutus*' probably refer to *S. babu* or other species, but are of some limited interest. Howlett (1913) reported that at Pusa *P. minutus* fed on geckos and bit man in summer. Lloyd & Napier (1930) recorded a considerable proportion of *P. minutus* biting man, but Shortt (1931*a*) questioned the methods of identifying flies and blood meals. Napier (1931) insisted that some '*P. minutus*' could bite man in Calcutta, specially *babu* and *shorttii*. Shortt (1931*b*) commented briefly on the precipitin test, and (1932*b*) reproduced his 1931*a* paper. Mitra (1956 : 234) found that two species, probably *S. babu* and *S. bailyi*, bit man readily in the laboratory.

S. punjabensis has been taken on or near animal bait without actually being seen to bite (Lewis, 1967 : 50), and Pandiya *et al.* (1972) reported this and a related species biting cattle.

S. babu attacks geckos in India and was said to bite man in Mauritius (Adler & Theodor, 1957), but Theodor (1965, in letter) informed me that the man-biting in Mauritius was recorded on an old label and needed checking. *S. babu* can bite birds in Pakistan (George, 1970).

S. baghdadis has been found on or near animal bait in Pakistan (Lewis, 1957 : 50), and one female examined by George (1970) had fed on man.

Raynal (1936*a* : 366) found that a female of *S. barraudi* in Tonkin had fed on man.

S. shorttii bit geckos in a cage in India, taking up to 20 minutes or more to feed (Shortt & Swaminath, 1931 : 544), and was said by Napier (1931) to be able to bite man.

The normal host of *S. indica* is unknown but, to judge from an observation on *S. squamipleuris* in Africa (Kirk & Lewis, 1951), it may well be the species seen by Howlett (1909 : 240) to bite frogs.

The above-mentioned capture of *S. gemmea* in a monkey-baited trap may have been due to attraction. *S. gombaki*, in the Gunong Besout area of West Malaysia, fed to repletion on the face, hand and foot of collectors, in camp or near a tree hole, and appeared to be often attracted to people, and in the same area *S. iyengari* was taken in a trap baited with leaf monkeys (Knudsen *et al.*, 1978). *S. malayae* has been found on or near animal bait, recorded by Lewis (1957 : 165) as *S. zeylanica* which has bitten man in an Indian jungle (Sinton, 1928*c* : 320).

S. bailyi was found to have bitten fowls in Indo-China (Raynal, 1936*a*; 1936*b*). A female of this species, posted on 26.vii.1962 by the entomologist of the Department of Agriculture, Dacca, to the Commonwealth Institute of Entomology, was stated to have come from the larva of a grain moth, *Sitotroga cerealella* (Olivier). The ovaries were partly developed and the midgut contained an inner peritrophic membrane and a large mass of cells of unknown origin, each about 2 μm long, with a large nucleus, and visible in Berlese's medium.

Banks (1919*b*) collected *S. nicnic* in one place in the Philippines where it was abundant at

times, was attracted to lights, attacked man persistently and gorged slowly. Quate & Rosario (1962) questioned this account of biting but Quate (1965 : 28) reported it biting man.

S. reidi and *S. traubi* have been taken on or near mammal bait (Lewis, 1957 : 165). *S. clydei*, known to bite mammals in Africa, has, as noted above, once been taken on human bait in India.

Seasonal prevalence

In temperate climates some species of sandflies emerge from winter diapause and pass through one or two annual generations which determine their seasonal incidence. In the tropics seasonal occurrence seems to depend on specific biology and local conditions. Some species occur throughout the year. Some flourish in the dry season when breeding places are not flooded. Others are numerous in the rains, when high humidity may favour the adults and larvae of woodland species.

Existing knowledge of seasonal changes in the Orient is summarized below, and seems to reflect the gradual transition from temperate to tropical conditions.

In Lahore, Pakistan, Nasir (1958) found sandflies from February to November, and George (1970) noted a sharp decline in October and November. Dhanda & Modi (1971 : 1567, 1569) pointed out that in Pakistan sandflies tend to vanish in winter and to appear in March and become numerous in April and in the damp month of August, whereas in peninsular India they persist in the milder winter in Aurangabad (Deccan) and Poona districts; around Aurangabad sandflies were abundant throughout most of the year, were most numerous when the monsoon began in June and diminished in December. At Pusa, in Bihar State, Howlett (1909) noted that sandflies were common in late September and early October. Smith (1959 : 17) reported that in north-east India sandflies might vanish in the winter in December and January, and diminish again in midsummer, being numerous after the monsoon, from August to October; in south India numbers were lowest in hot dry months. In Indo-China sandflies were rare in the colder part of the winter from January to March (Raynal, 1936*a* : 353), and at Phnom Penh in Cambodia various species seemed to disappear in winter (Parrot & Clastrier, 1952).

Around Pusa Howlett (1915) observed that larvae of *P. papatasi* which hatched at the start of the cold weather pupated in late February or early March according to temperature, and Craighead & Das (1928) reported that the species increased somewhat in the rains. In north Bengal it was common in April (Brunetti, 1920). In Poona district *P. papatasi* was common throughout the year (Mitra, 1956), and in Bombay City seemed to diminish in the rains (Young, 1927).

Mitra (1959) reported *P. sergenti* from March to October in Punch and Riasi. Sinton (1924*f*) encountered sandflies in Indo-Pakistan in summer, mainly in the less hot period, and found *P. major* in the hills in summer.

At Gauhati in Assam adults of *P. argentipes* were rare from late December to early February but larvae could be found (Kala-azar Commission, 1932 : 155). Mitra (1955 : 82) saw it throughout the year in parts of Maharashtra State and (1956) noted that it was common all the year in Poona district. Sinton (1924*f*) reported that sandflies might occur all the year round in southern and eastern India, and that *P. argentipes* was common and could be found in most parts of the year all along the coast from Bengal to Sri Lanka. Brunetti (1912) recorded it throughout the year at Calcutta, where Bhasu & Ghosh (1954*a*; 1955) found that it reached a peak in July and was least numerous in January.

In China, Tang & Maa (1945) found *P. hoepplii* from April to July and in September and October.

Around Pusa *S. indica* increased somewhat in the rains (Craighead & Das, 1928).

Raynal (1936*a* : 364, 366) reported that *S. barraudi*, an upland species in Indo-China, disappeared from the northern lowlands in summer, and that in Annam *S. bailyi* occurred throughout the year but diminished in the cool weather.

Natural enemies

A number of parasites and predators have been reported by Bhattacharya & Biswas (1968), the Kala-azar Commission (1932 : 158), Lewis & Killick-Kendrick (1973), Lewis (1967), Mitra

(1956 : 234), Mitra & Mitra (1953), Mohan & Suri (1975), Napier & Smith (1926), Rathnaswamy & Rama Krishna (1954), Shortt & Swaminath (1931) and Subramaniam & Suri (1975). *Culicoides* have been found attached to *P. argentipes* according to Smith & Swaminath (1932 : 183) and Das Gupta (1964 : 6, 7).

Relation to disease

The effect of bites

P. papatasi is a very troublesome biter in parts of Pakistan, and has caused intolerable itching which could lead to secondary infection (Howlett, 1909 : 240; Sinton, 1924 : 1036; 1925*b* : 702).

Viruses

The following general summary is based on the work of Tesh & Chaniotis (1975), Tesh *et al.* (1975) and other authors mentioned below. Sandfly-borne viruses of vertebrates may have evolved from arthropod viruses, and belong to three distinct serogroups, vesicular stomatitis, phlebotomus fever and (American) Changuinola. Unlike most vertebrate arboviruses, they seem unable to produce a significant viraemia in infected animals or man. Most individual infected vertebrates are probably dead-end hosts, and the viruses are likely to be maintained by insect-to-insect transovarial transmission. Vesicular stomatitis virus infects a number of animals, including man. Chandipura virus, a member of this group, was first isolated from sick persons in India and has been recovered from wild sandflies there (Modi & Dhanda, 1972).

The phlebotomus fever group includes at least 25 serotypes with eight in the Old World (Tesh *et al.*, 1977*a*; 1977*b*); most have been recovered from sandflies, and at least five cause sandfly fever. Human involvement shows a parallel with leishmaniasis. In tropical America sporadic cases depend on contact with sylvan sandflies, and in the Middle East and Central Asia (and in North Africa, Perfil'ev, 1968) the vector (*P. papatasi*) is domestic. The view that other vectors exist (Mattingly, 1973 : 166) was probably partly based on incomplete knowledge of the distribution of *P. papatasi.*

With regard to the Oriental Region, Mitra (1954*b*) reported that sandfly fever in India was widespread during the warm months in the Punjab plains, Delhi, Uttar Pradesh, Bihar, Bengal, Madhya Pradesh and Bombay; in Punjab, Delhi and western Uttar Pradesh there were spring and autumn outbreaks related to multiplication of sandflies in hot, relatively damp, weather. Barnett (1962) isolated a number of viruses from several species of sandflies in Pakistan, and Lewis (1967) quoted other records from that country. George (1970 : 674, 676) found plebotomus fever in Pakistan and considered that an epidemic was likely to follow the cessation of malaria control. Rao (1975 : 1226) recorded both Sicilian and Naples strains from India. Goverdhan *et al.* (1976) isolated both of these from the Aurangabad area, mainly in June, and regarded *P. papatasi* as the main vector of both forms. They demonstrated a problem previously encountered in Pakistan, that the success of a virus survey depends largely on fluctuating prevalence of the virus.

The sandflies from Gunong Besout Forest Reserve in West Malaysia recorded in Table 3 were part of a collection made during a search for viruses by A. B. Knudsen and R. B. Tesh (1977, in letter) and their colleagues. Altogether 14 636 flies (5308 of them females) were processed but without result. Nearly all the sandflies identified were species of *Sergentomyia.* The survey contributes to the world picture of phlebotomus fever virus by suggesting that flies of this genus play no significant part in the epidemiology, despite reports of a few isolations from *Sergentomyia* elsewhere. Comparable results were obtained by Tesh (1977, in letter) who processed 2500 female and male sandflies from Taiwan where, as in most of the Old World tropics, species of *Sergentomyia* outnumber those of *Phlebotomus.*

Dermal leishmaniasis

The following summary of dermal, and that of visceral, leishmaniasis is based largely on the work of Adler & Theodor (1957), Garnham (1973) and Napier (1946).

Dermal leishmaniasis, generally known as Oriental sore in the Old World, and sometimes locally as Delhi boil or Lahore sore, is caused by the trypanosomatid protozoan parasite *Leishmania tropica* (Wright, 1903). *Le. t. major* Yakimov (1915) is the parasite of rural zoonotic moist dermal leishmaniasis in the U.S.S.R., and *Le. t. minor* Yakimov (1915) causes the urban anthroponotic dry form. In the Indian subcontinent the dry form is generally prevalent (Sen Gupta, 1968). It occurred over the western and drier parts of the Indo-Gangetic plain and was endemic in Pakistan. It existed down the west coast of India as far as Cambay, and east as far as Delhi, and Sinton (1925*b*) regarded the Bombay–Tashkent line as the eastern limit. In an epidemic in Delhi in 1940 there were some 20 000 cases (Sharma *et al.*, 1973*c*). Farooq & Qutubuddin (1945) and Sen Gupta (1967) gave further details of distribution.

P. papatasi is a well-known vector of *Le. tropica* in the Old World. Sinton (1924*b*) pointed out that it was much more widespread than the disease in Indo-Pakistan, but Sen Gupta (1967) considered that it was the principal vector. Sinton (1922 : 579; 1925*b* : 716, 717) compared the distribution of Oriental sore with that of *P. sergenti*, and Sinton & Shortt (1934) noted their coexistence, with *P. papatasi*, in Karnal. Mitra (1934*b* : 311) considered the question of vectors to be undecided, Sen Gupta (1968) thought *P. sergenti* played some part in transmission, and Sharma *et al.* (1973*c* : 69) believed that *P. sergenti* might be the main vector, with *P. papatasi* playing some part.

Sen Gupta (1968) mentioned that *S. christophersi* had been suspected as a vector, but there seems to be no evidence for this, or even for it biting man. On the basis of this report, however, the species has been quoted as a habitual vector in a recent paper on North Africa.

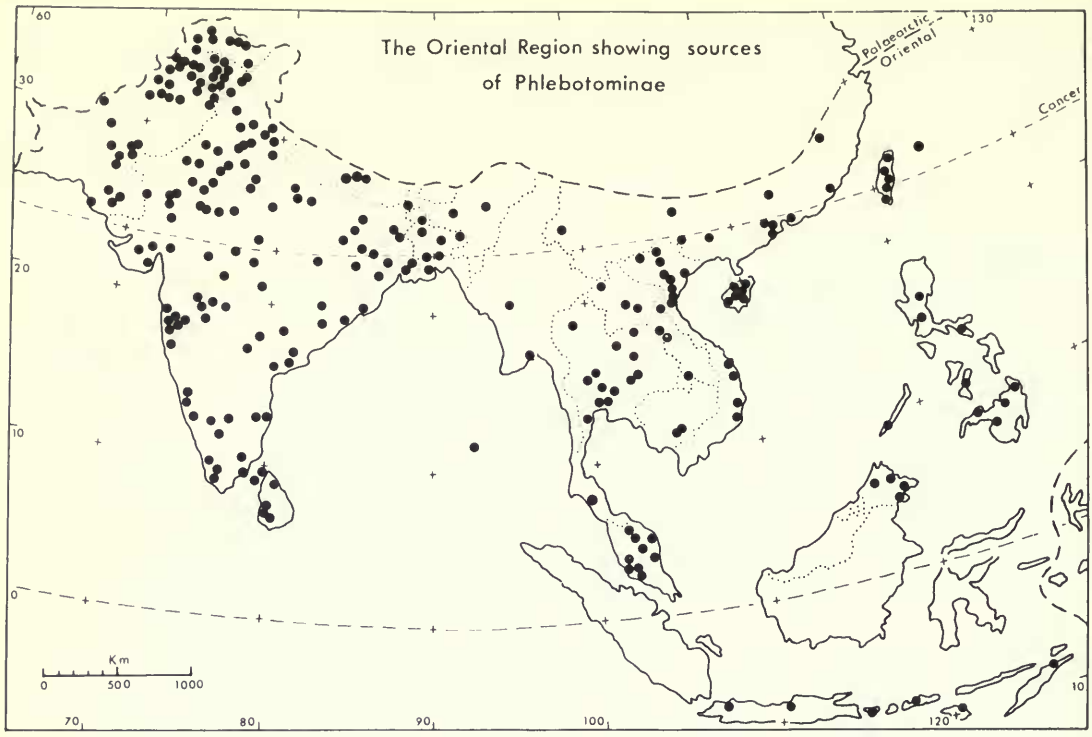
No animal reservoir was known for a long time (Mitra, 1954*b*), and Garnham (1965 : 146) felt that this extremely common disease had practically ceased to be a zoonosis in India, but Sen Gupta (1968) thought one might exist. Now there is strong evidence of a gerbil reservoir (Sharma *et al.*, 1973*b*), and the probable vector among the animals (Kalra & Lewis, 1976) is *P. salehi*. Mohan & Suri (1975) have isolated from it parasites which are probably *Le. tropica* and may be *Le. t. major*.

House spraying for malaria control made Oriental sore rare in Pakistan (Nasir, 1964). In parts of India spraying from 1958 onwards caused a transient disappearance for more than ten years, but an epidemic in Bikaner reached a peak in 1971 (Sharma *et al.*, 1973*a*; 1973*c*), and the disease has reappeared in several areas (Kaul *et al.*, 1976).

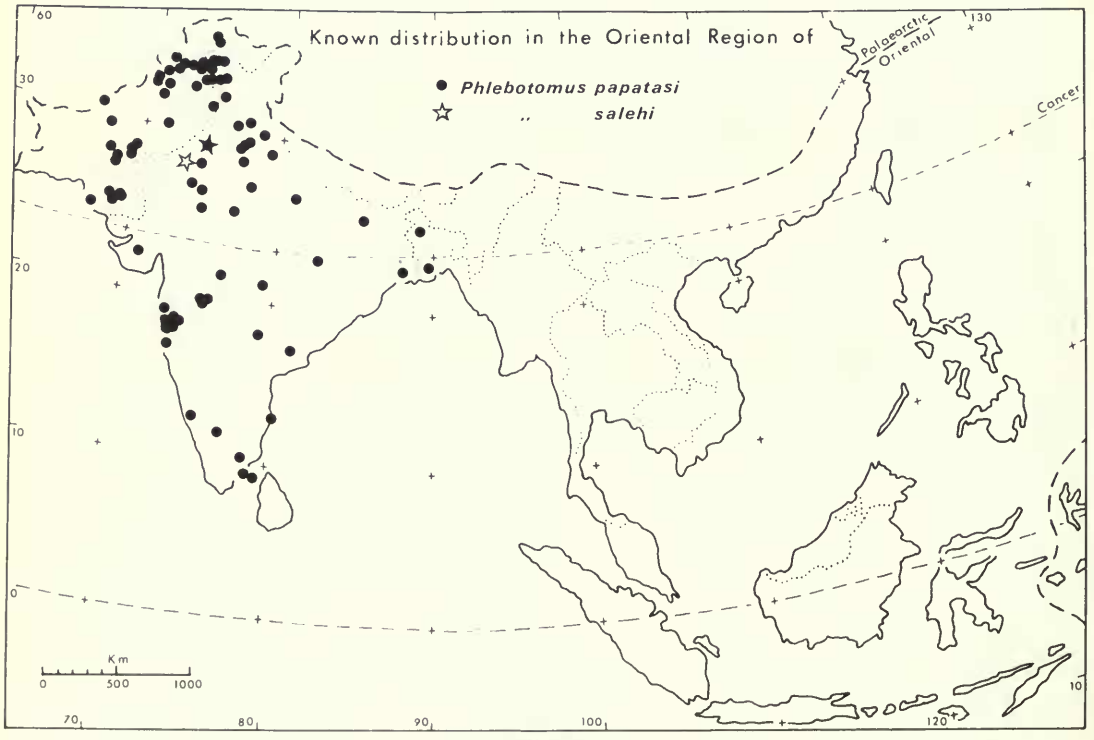
Visceral leishmaniasis

This disease, known as kala-azar, is caused by *Le. donovani* (Laveran & Mesnil, 1903), and India is one of the few countries with no known animal reservoir, though Adler (1964) believed the disease might have developed from a zoonosis and he and Garnham (1965) and Hoare (1955) thought that the infection might still be found in a wild animal. The name kala-azar, meaning black fever, came from the Garo Hills in India, where it referred to the appearance of victims. Before treatment was discovered about 75 per cent of patients died, mostly within two years. Sen Gupta (1968) reported a death rate of 90–95 per cent among infected people and a general mortality of over 25 per cent in some districts. The terror of this once-deadly disease caused many people to desert their villages (Manson-Bahr, 1946), and its severity and tendency to spread led to enormous loss of life, depopulation and failure of agriculture (Sen Gupta, 1967).

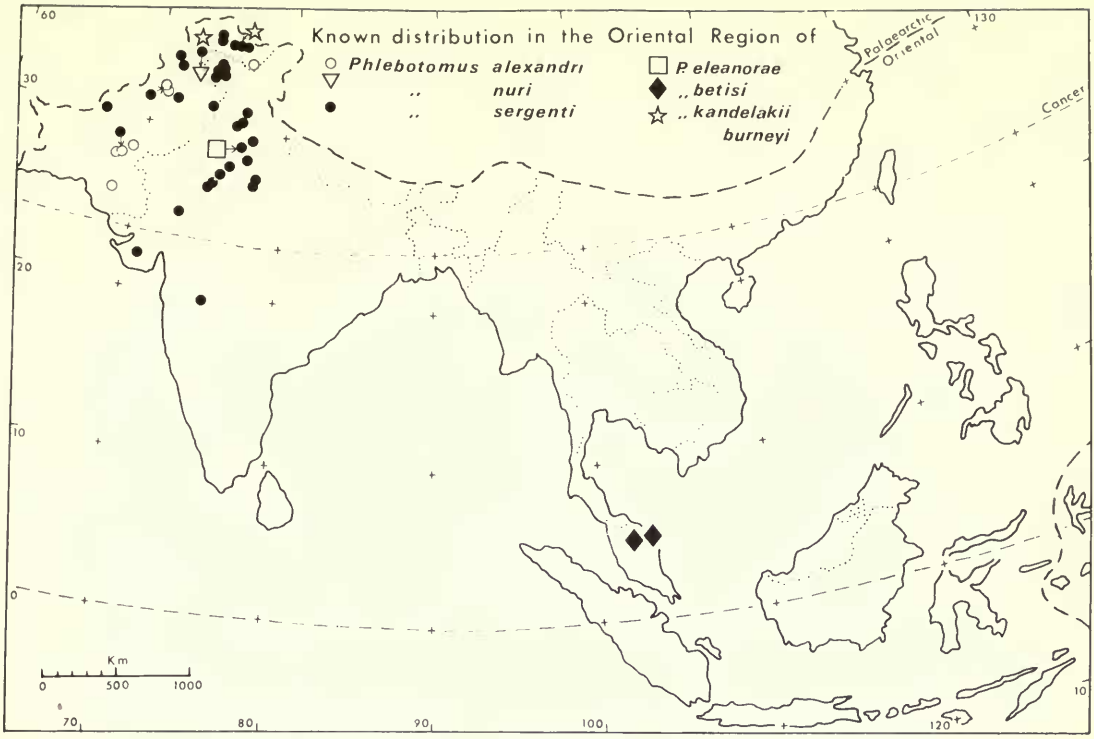
Several epidemics occurred in Bengal and were confused with malaria till treatment failed to prevent many deaths. Kala-azar attracted special attention when it began to invade Assam in 1875 with the development of communications (Sen Gupta, 1967*a*). Between then and 1917 it swept up the Brahmaputra valley in three distinct epidemic waves. There were epidemic periods of about ten years and inter-epidemic periods of 15–20 years (Shortt, 1945). Before 1946 the disease was known to be widely distributed in India but the epidemic areas were well defined (Napier, 1926 : 224). Infections occurred near Cape Cormorin and in Madras, and from there the coast was free till the Ganges delta. The plains of Bengal were heavily infected, and the endemic area extended along the Ganges plain into Bihar and to the eastern side of Uttar Pradesh as far as Lucknow. To the north-east, Assam was heavily infected as far as Sibsagar. Extensions


The Oriental Region showing sources
of Phlebotominae
Palaearctic
Oriental
Cancer
60
30
20
10
0
130
10
Km
0
500
1000
70
80
90
100
120

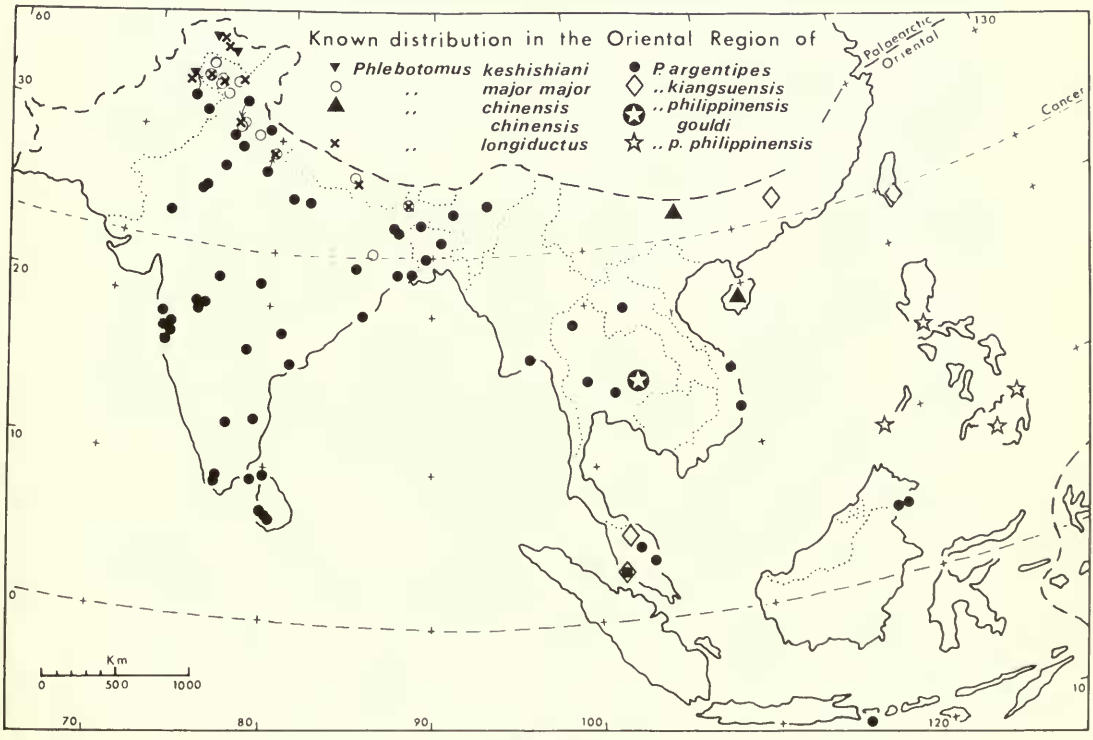
Map 1


Known distribution in the Oriental Region of
Phlebotomus papatasi
" salehi
Palaearctic
Oriental
Cancer
60
30
20
10
0
130
10
Km
0
500
1000
70
80
90
100
120

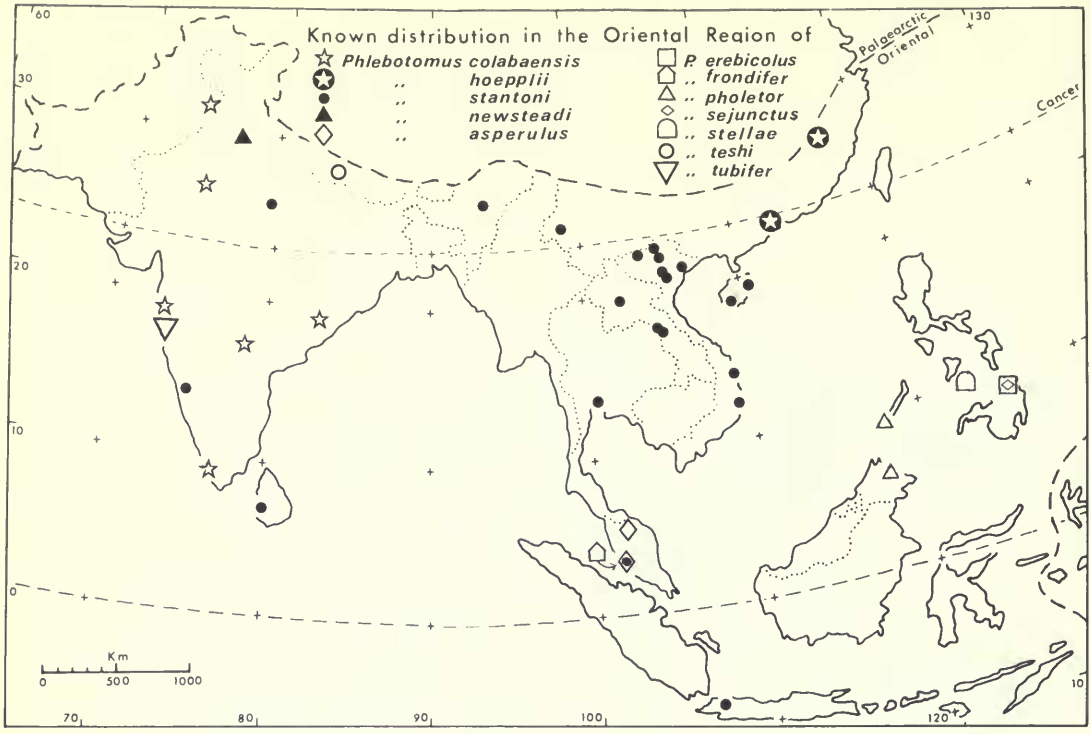
Map 2


Known distribution in the Oriental Region of
Phlebotomus alexandri
,, nuri
,, sergenti
P. eleanorae
,, betisi
,, kandelakii burneyi
Palaearctic
Oriental
Cancer
Km
0 500 1000

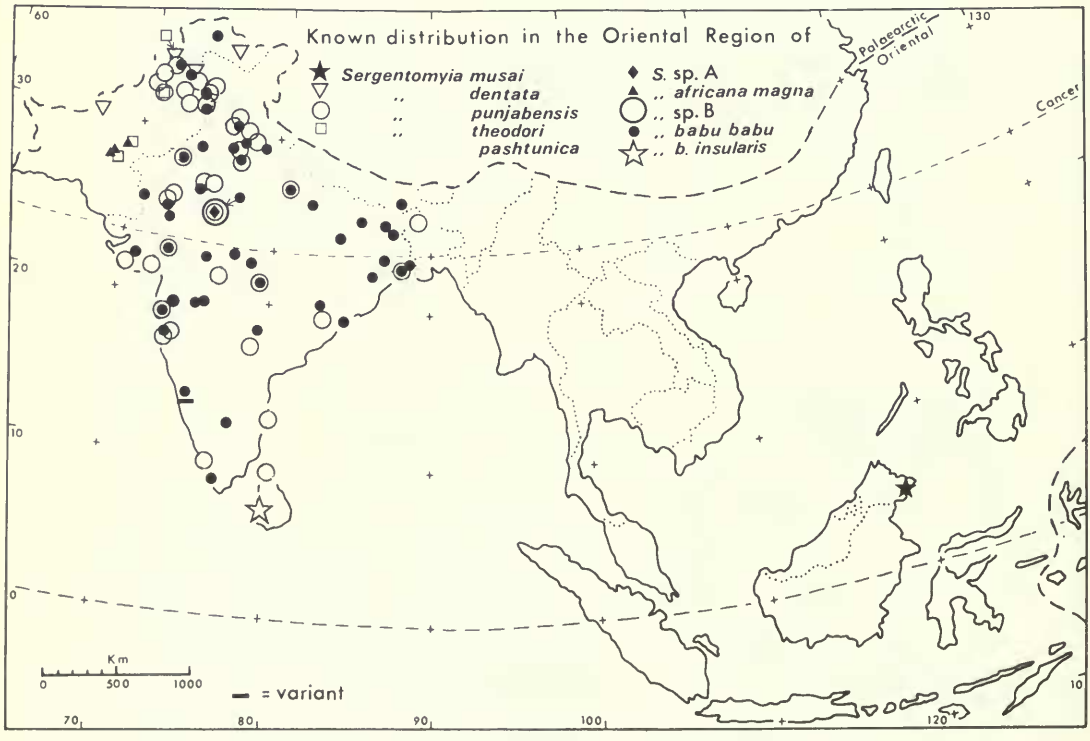
Map 3


Known distribution in the Oriental Region of
Phlebotomus keshishiani
,, major major
,, chinensis chinensis
,, longiductus
P. argentipes
,, kiangsuensis
,, philippinensis gouldi
,, p. philippinensis
Palaearctic
Oriental
Cancer
Km
0 500 1000

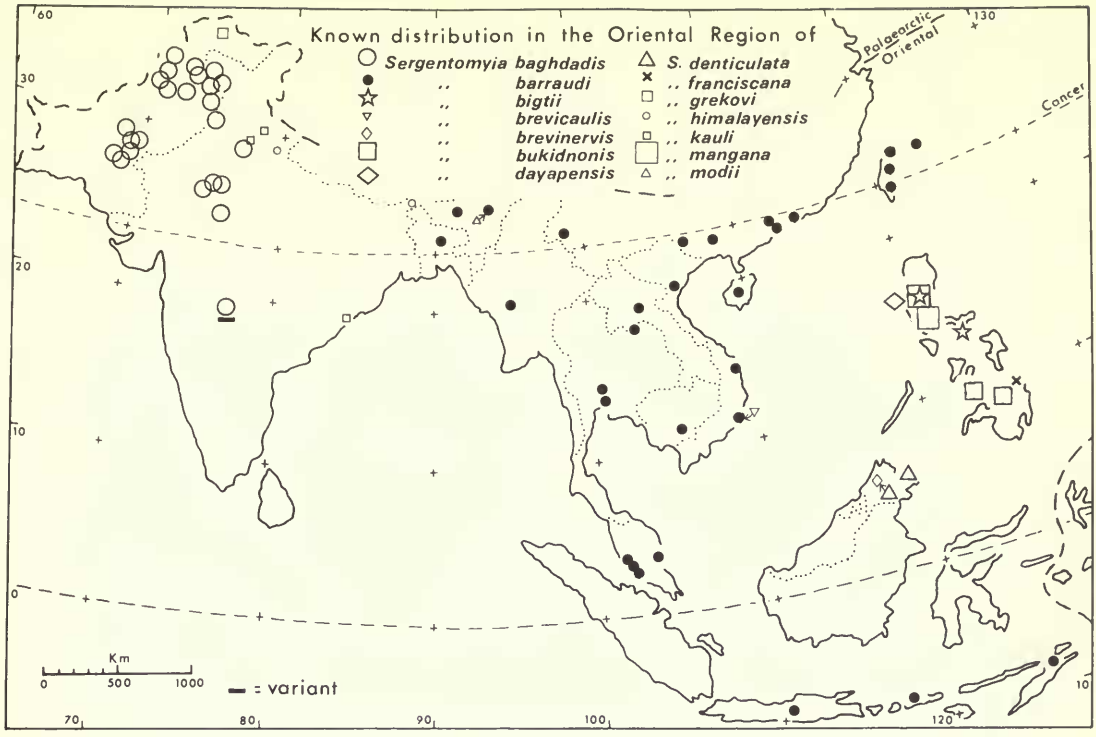
Map 4


Known distribution in the Oriental Region of
Phlebotomus colabaensis
,, hoepplii
,, stantoni
,, newsteadi
,, asperulus
P. erebicolus
,, frondifer
,, pholetor
,, sejunctus
,, stellae
,, teshi
,, tubifer
Palaearctic
Oriental
Cancer
Km
0 500 1000

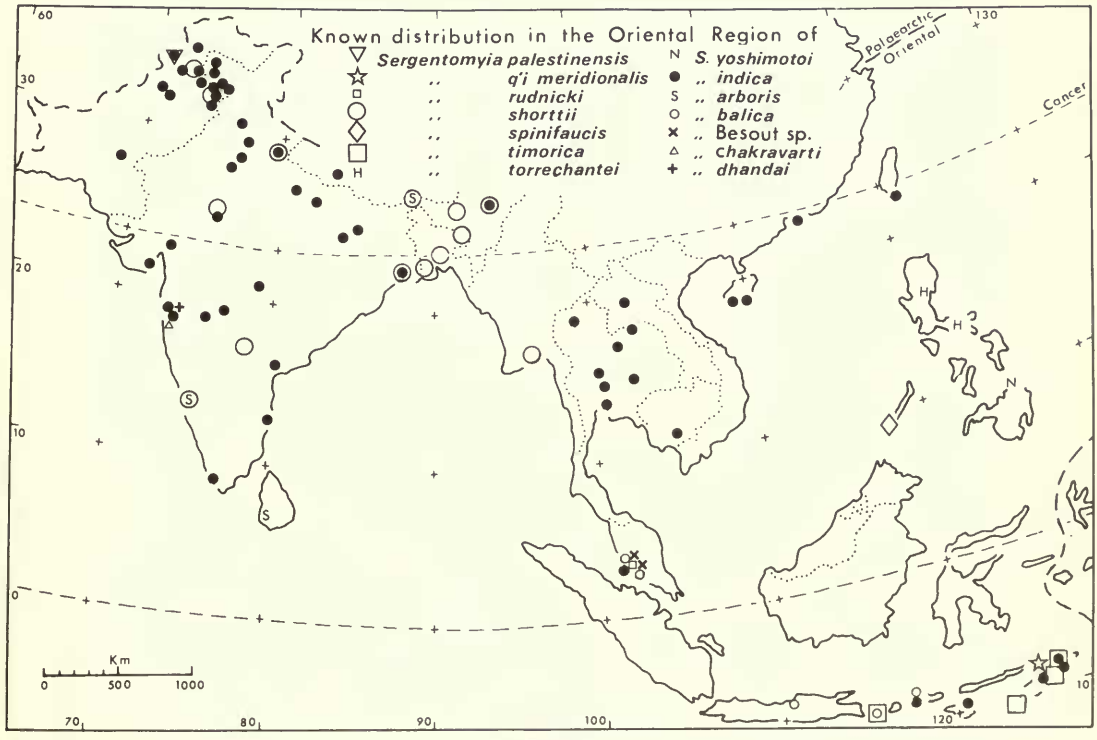
Map 5


Known distribution in the Oriental Region of
Sergentomyia musai
,, dentata
,, punjabensis
,, theodori
pashtunica
S. sp. A
,, africana magna
,, sp. B
,, babu babu
,, b. insularis
Palaearctic
Oriental
Cancer
Km
0 500 1000
= variant

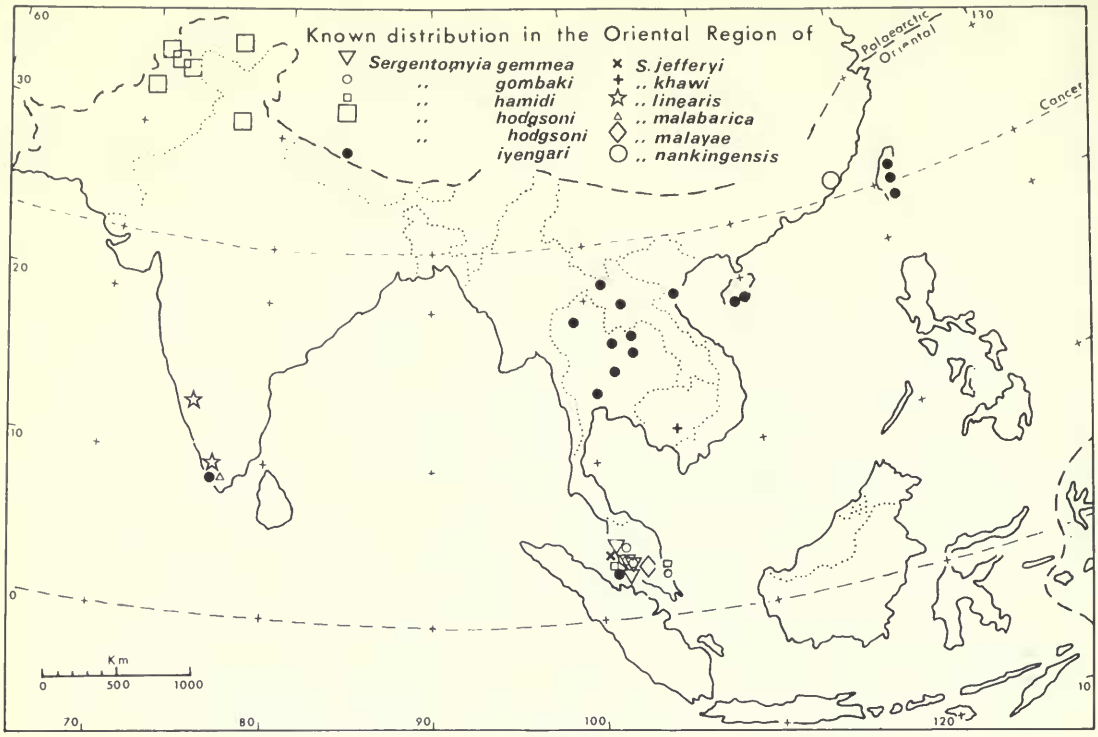
Map 6


Known distribution in the Oriental Region of
Sergentomyia baghdadis
,, barraudi
,, bigtii
,, brevicaulis
,, brevinervis
,, bukidnonis
,, dayapensis
S. denticulata
,, franciscana
,, grekovi
,, himalayensis
,, kauli
,, mangana
,, modii
Palaearctic
Oriental
Cancer
Km
0 500 1000
= variant

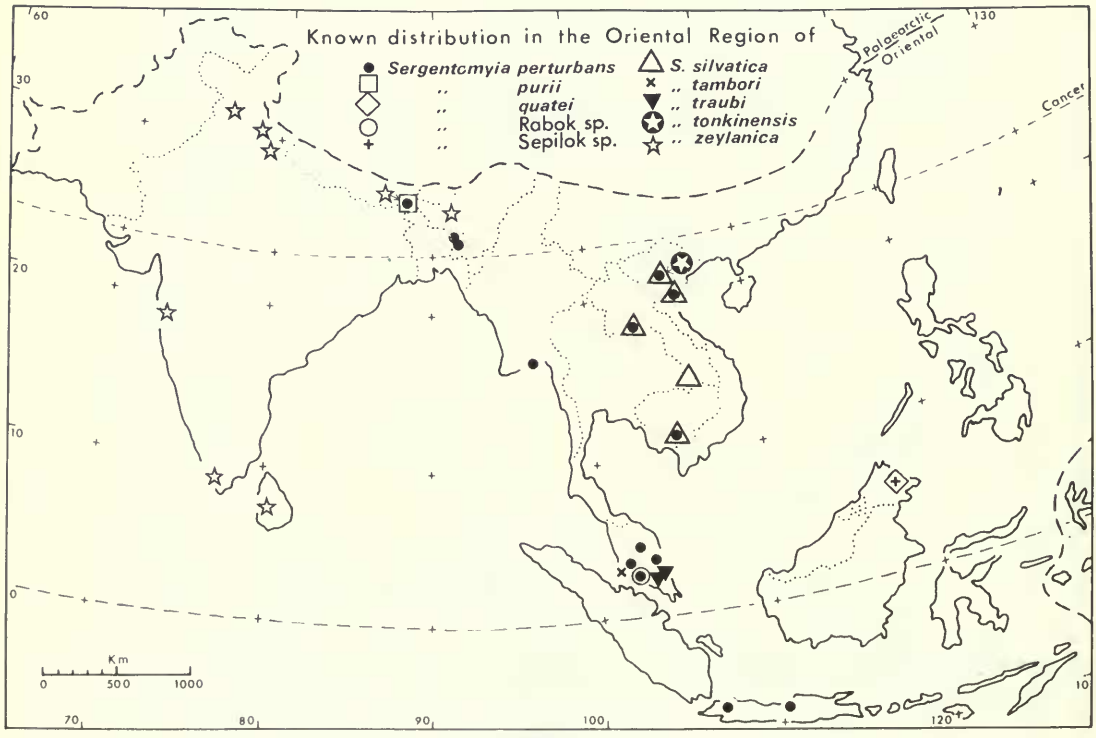
Map 7


Known distribution in the Oriental Region of
Sergentomyia palestinensis
,, q'i meridionalis
,, rudnicki
,, shorttii
,, spinifaucis
,, timorica
,, torrechantei
S. yoshimotoi
,, indica
,, arboris
,, balica
,, Besout sp.
,, Chakravarti
,, dhandai
Palaearctic
Oriental
Cancer
Km
0 500 1000

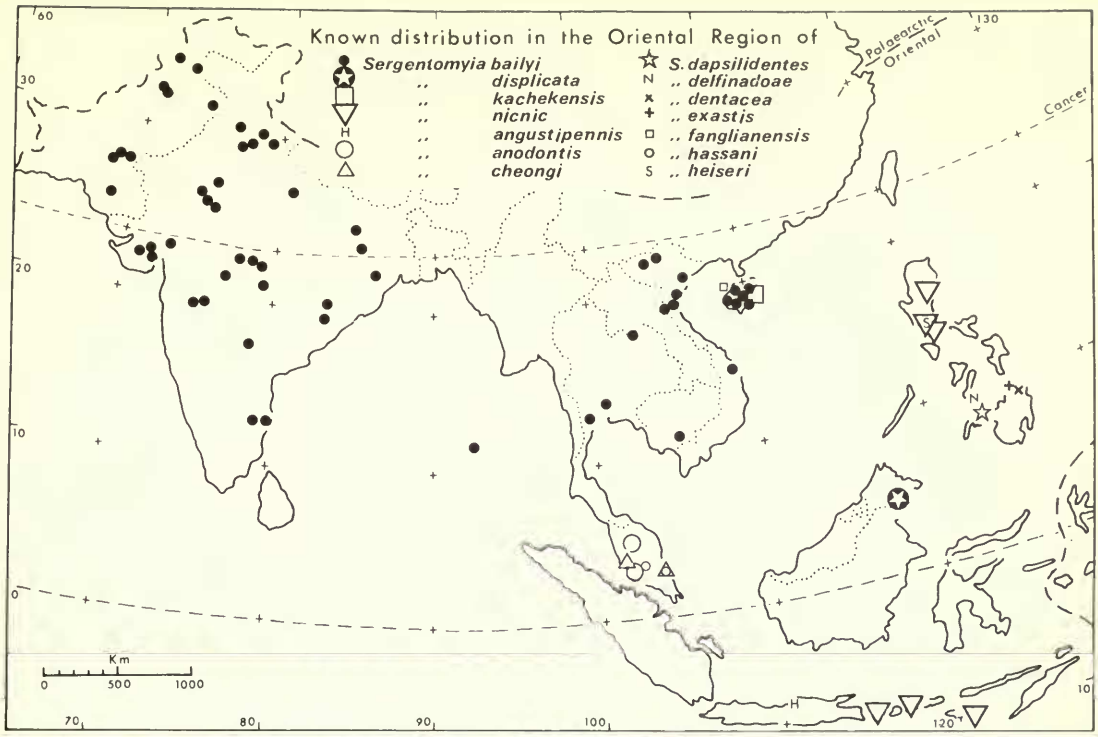
Map 8


Known distribution in the Oriental Region of
Sergentomyia gemmea
,, gombaki
,, hamidi
,, hodgsoni
,, hodgsoni iyengari
S. jefferyi
,, khawi
,, linearis
,, malabarica
,, malayae
,, nankingensis
Palaearctic
Oriental
Cancer
Km
0 500 1000

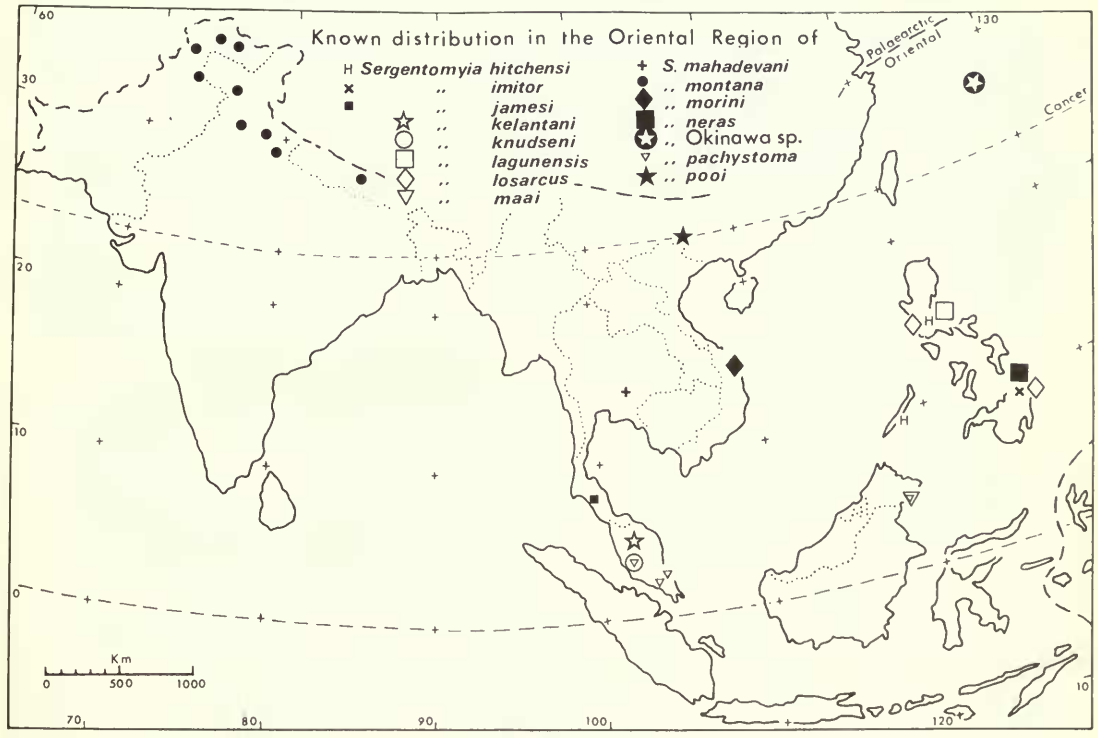
Map 9


Known distribution in the Oriental Region of
Sergentomyia perturbans
,, purii
,, quatei
,, Rabok sp.
,, Sepilok sp.
S. silvatica
,, tambori
,, traubi
,, tonkinensis
,, zeylanica
Palaearctic
Oriental
Cancer
Km
0 500 1000

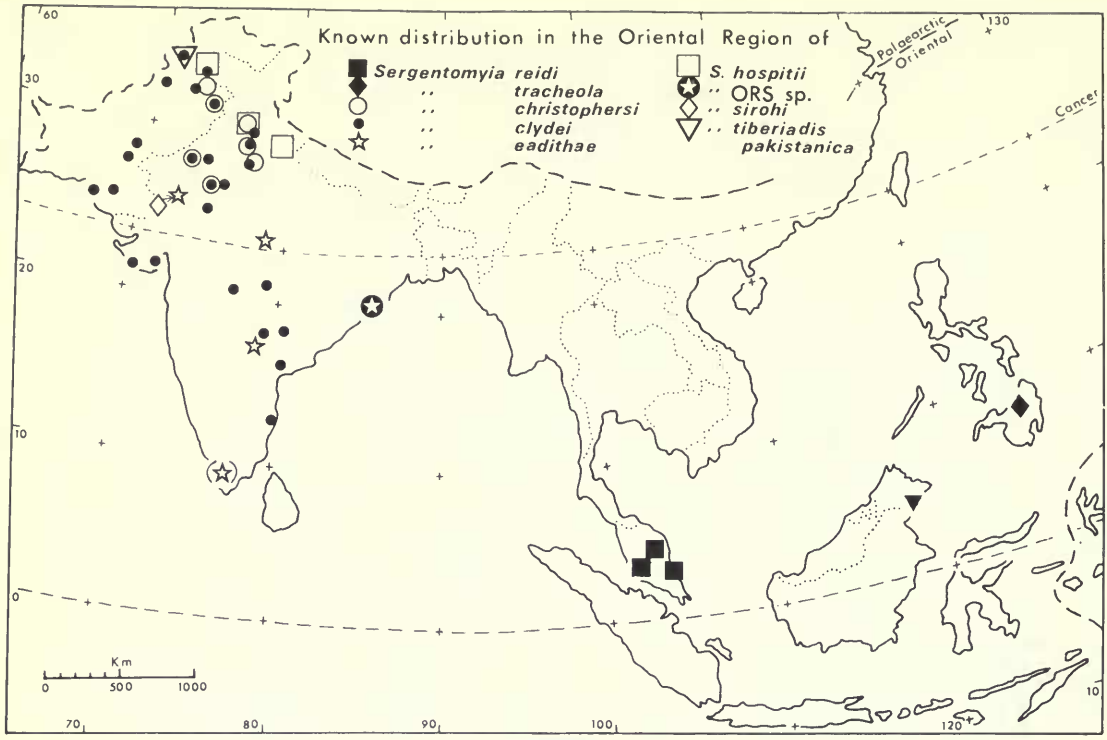
Map 10


Known distribution in the Oriental Region of
Sergentomyia bailyi
,, displicata
,, kachekensis
,, nicnic
,, angustipennis
,, anodontis
,, cheongi
S. dapsilidentes
,, delfinadoae
,, dentacea
,, exastis
,, fanglianensis
,, hassani
,, heiseri
Palaearctic
Oriental
Cancer
Km
0 500 1000

Map 11


Known distribution in the Oriental Region of
Sergentomyia hitchensi
,, imitor
,, jamesi
,, kelantani
,, knudseni
,, lagunensis
,, losarcus
,, maai
S. mahadevani
,, montana
,, morini
,, neras
,, Okinawa sp.
,, pachystoma
,, pooi
Palaearctic
Oriental
Cancer
Km
0 500 1000

Map 12



Map 13

from Bengal to the east were limited by mountains. The disease could occur in periodic epidemics or in epidemic invasions. Kala-azar was in general confined to rural areas below 610 m with an annual relative humidity of 70 per cent or more and a mean diurnal temperature range of 11 °C or less. In Bengal there were peaks about January and November. General distribution was described by Omran (1961), Shortt *et al.* (1928) and Sen Gupta (1968) who (1958) recorded an epidemic between 1940 and 1949.

Kala-azar was rare in the west (Gajwani *et al.*, 1967), but has appeared in Gujarat State, where it may have been introduced (Vaishnav *et al.*, 1970; Munshi *et al.*, 1972), and in Maharashtra and Rajasthan (Wattal, 1973).

The disease exists in the absence of *P. argentipes* in Kashmir and south China, probably as extensions of Palaearctic kala-azar. Jacob & Kalra (1951) reported it from Kashmir where *P. chinensis*, the Chinese vector, and *P. kandelakii* occur (Lewis, 1967), and south Chinese kala-azar was found after the war of 1937 (Omran, 1961).

There are records of kala-azar, often isolated or imported cases, from several other Oriental countries, in some of which *P. argentipes* is strongly zoophilic (Lewis, 1974*a* : 372): Bangladesh (WHO, 1968), Borneo, South Vietnam, Sumatra, Thailand, West Malaysia (American Geographical Society, 1954), Burma (Rangoon, Omran, 1961), China (Canton, Theodor, 1964; Che Kiang Province, WHO, 1968), Pakistan lowlands (Lewis, 1967), Sri Lanka (Castellani, 1904; Senadhira, 1967) and Taiwan (leishmaniasis, Drutz *et al.*, 1969).

With regard to transmission, Mackie (1915) urged that sandflies should be studied as possible vectors. Christophers (1926) pointed out that kala-azar was largely associated with alluvium, fairly heavy rainfall and the distribution (Sinton, 1925*b*) of *P. argentipes*. A heavy flagellate infection developed in about 25 per cent of flies fed on a kala-azar patient (Knowles *et al.*, 1924). Shortt *et al.* (1920) and Shortt (1932*a*) showed that the infection passed forward to the cibarium. It was later found that flies could be infected by people with post kala-azar dermal leishmaniasis. After nearly 40 years of investigation Smith *et al.* (1941) showed that many infected flies fed on

plant juices developed forward infections. Finally, Swaminath *et al.* (1942) transmitted the disease to volunteers. *P. argentipes* could be found throughout the year in Bengal and Assam but was most prevalent in and just after the monsoon. Cows seemed to attract the sandfly to dwellings but divert it from man to some extent.

A treatment campaign in 1922 had preventive value, but residual cases made complete success impossible. Mass treatment reduced much transmission (Shortt, 1945) but did not prevent epidemics recurring (Sen Gupta, 1967, 1968), and even in 1937 there were many deaths (Ansari, 1962). After the last of these big epidemics ended in 1924 periodicity became disturbed, probably by insecticide campaigns (Theodor, 1964). In 1953 DDT began to be used in the Indian national malarial control programme (Das *et al.*, 1976), and declining incidence was further reduced (Sen Gupta, 1958), but when control had ceased in Bengal, Das & Mukherjee (1969*a*) and Sen Gupta (1973) realized the risk of some recrudescence, and Boreham (1975 : 89) suggested that houses should be sprayed specifically against sandflies. Tests have indicated that they are normally susceptible to insecticides (Basu & Ghosh, 1954*b*; Sen, 1959; Raghavan *et al.*, 1967). Sen Gupta (1975) reported that kala-azar, once reduced to a rarity, had increased in some areas and spread to new ones. He called for renewed residual spraying against both malaria vectors and sandflies, and indicated the possible value of spraying in the vicinity of infected people. Das *et al.* (1976) warned of the danger of a new outbreak. Seal (1977) considered that treatment, rather than DDT, had previously reduced kala-azar, and he reported an alarming increase and urged the study of direct transmission from man to man. According to available information (A. B. Chowdhury, 1978, in letter) about 70 000 cases of kala-azar, with about 4 000 deaths, were encountered in August 1977 in an area comprising the four districts of Bihar State, Muzzaffapur, Samastipur, Sitamarhi and Vaishali, and it was estimated that 30 000 more cases might exist in other districts. Large-scale spraying and treatment were evidently needed to prevent the cases increasing to 200 000 and to end the outbreak (Anonymous, 1977).

Acknowledgements

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In the selection of the following works a number have been omitted, particularly some old ones on bionomics and relation to disease.

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Invalid names are in *italics*. Principal references are in **bold**.